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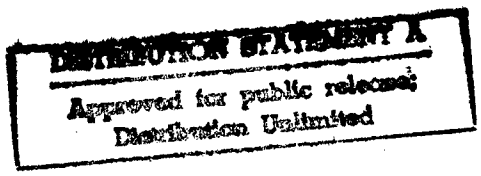
USSR Report

MATERIALS SCIENCE AND METALLURGY



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MATERIALS SCIENCE AND METALLURGY

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UDC 621.793:621.7.044.2.001

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Kiev POROSHKOVAYA METALLURGIYA in Russian No 5, May 86 (manuscript received 20 Feb 85) pp 55-58

[Article by A. M. Kaunov, L. N. Burminskaya, V. M. Bukin and I. M. Ryadinskaya, Volgograd Polytechnic Institute]

[Abstract] Deposition of liquefied powder coatings on substrates by the shock-wave method is characterized not only by high pressure but also by very high heating rates (of the order of 10^9 °C/s) and cooling rates of the order of 10^6 °C/s). The critical impact and sliding velocities, on which transition from solid-phase to liquid-phase coating formation depends, were sought in an experimental study which involved coating of 17MnSi steel and M1 copper with Ni, Cr, 12Cr18Ni9 steel, and Ti powders. The shock-wave impact velocity was varied over the 0.4-2.5 km/s range and the shock-wave sliding velocity, along the substrate surface, was varied over the 3.5-11.1 km/s range. Microstructural examination of the coatings under an MIM-8 microscope and their chemical analysis by thex-ray microspectral method with a "Kameka" instrument revealed a dendritic structure of Ni coatings and a sponge structure of all the other coatings, with the substrate material participating in structurization of both the coating and the thin interlayer. Tests have yielded two critical impact velocities for each coating material, a subsonic one and a supersonic one depending on the sliding velocity, at which transition from one mechanism to the other occurs. Calculations based on the Kaunov-Shamrey approximation for the subsonic case and on the Clapeyron-Clausius equation for the supersonic case, taking into account the pressure dependence of aggregation and thermophysical properties, confirm these results. References 6: 4 Russian, 2 Western (both in Russian translation).

2415/12947
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THERMAL OXIDATION OF In_2S_3/GaAs STRUCTURES

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 22, No 6, Jun 86 (manuscript received 17 Sep 84) pp 885-888

[Article by I. Ya. Mittova and V. V. Pukhova, Voronezh State University imeni Lenin Komsomol]

[Abstract] Thermal oxidation of GaAs under an In_2S_3 surface layer was studied, for the purpose of determining the effect of such a surface layer on the composition and the properties of the resulting oxide film. Wafers of AGP-1 industrial and AGChO very pure GaAs, after they had been soaked in HF concentrate for 20 min and then in chrome mixture to ensure perfect surface wettability, were placed in a bath of glacial acetic acid with soluble $InCl_3$ and C_2H_5NS at a temperature of 50°C. This treatment produced in 3 h transparent specular 220-250 nm thick In_2S_3 layers with excellent adhesion to the substrate. Composition and thickness of these layers were monitored by x-ray spectral analysis and with an ellipsometer respectively. The resulting In_2S_3/GaAs structures, placed inside a quartz reactor with an electrical resistance heater, were oxidized with a stream of dry O_2 at various temperatures over the 350-600°C range held constant within $\pm$2°C each. The layer thickness was again measured with an ellipsometer, accurately within $\pm$1 nm. The data have been processed by the method of least squares according to the general equation of oxidation kinetics $d = K^n t^n$ (d- thickness of oxide film in nm, t - oxidation time in min, n- temperature-dependent numerical exponent) and the Arrhenius equation for the temperature-dependent growth rate constant K. The results reveal that an In_2S_3 surface layer retards thermal oxidation of GaAs, corresponding to an average value of the exponent $n_{aver} = 0.075$ instead of $n = 0.5$ or 1.0 for "pure" GaAs depending on the surface finish. It thus acts as a protective coating, with formation of In_2O_3 oxide anticipating formation of chemically similar Ga_2O_3 oxide, and also shields the substrate against vaporization of its volatile component so that elemental As embeds in it. The thermodynamics of possible reactions also favor retention of stable In_2O_3 with some As and InAs over its less probable conversion into glassy $InAsO_4$ with some As_2O_3 and InAs. This is confirmed by the results of electrical strength and resistivity measurements. No symptoms of crystallization were detected by x-ray spectroscopy with a DRF-20 diffractometer and a CoK_α-radiation source, indicating a microcrystalline or amorphous rather than the polycrystalline structure of the In_2O_3 films. References 14: 9 Russian, 5 Western (1 in Russian translation).

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DESORPTION OF As AND INTERACTIVE REACTIONS IN Au-GaAs SYSTEM DURING THERMAL ANNEALING

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 22, No 6, Jun 86 (manuscript received 6 Sep 84) pp 889-892

[Article by T. A. Bryantseva, G. G. Dvoryankina, Z. M. Lebedeva, A. B. Ormont, A. G. Petrov and Ye. O. Yunevich, Radio Engineering and Electronics Institute, USSR Academy of Sciences]

[Abstract] A study of thin-film Au/GaAs structures and their annealing was made, its purpose being to determine and analyze the temperature dependence of the As desorption rate as well as relation to interactive reactions. After 50-500 nm thick Au films had been deposited on the {100} surface of n-GaAs single crystals ($n = 10^{18}$ cm^{-3}) by the vacuum evaporation process, the structures were annealed under vacuum inside a quartz enclosure at temperatures covering the 573-870 K range. The amount of precipitating As was established by chemical analysis of the deposit on the walls after annealing. Migration of As and Ga into an Au film during its formation was recorded by an Auger electron spectroscopy with a "Riber" MBE-500 instrument using an ORS-103 Auger spectrometer and a cylindrical mirror as energy analyzer. Annealing was found to appreciably lower the As content in an Au film, to a level depending on the film thickness and on the annealing temperature as well as on its Ga,As,Ge impurity content acquired during deposition. Control experiments were performed with Au films on noninteracting substrates such as sapphire and annealing them in an atmosphere of As vapor. The results indicate that Au interacts not only with the GaAs substrate but also with As desorbed from the latter during film deposition. Dependence of the As content in an Au film on the film thickness is essentially a dependence on the Au grain size and the film defectiveness, both determined by the film thickness and both in turn determining the diffusion and the solubility of As. Hardly any interaction of Au and GaAs at the substrate surface is known to occur during annealing at temperatures far below 690 K, Au_3Ga or Au_7Ga_2 solid solutions beginning to form within the 573-623 K range. Further microstructural and phase analysis by electron diffraction reveals that a nonhomogeneous yellow film with protuberances begins to form at about 623 K, then a liquid phase containing Au_3Ga as well as solid solutions AuGa and $AuGa_2$ form within the 723-770 K range, while GaAs crystallizes into oriented islets reaching the film surface at about 870 K with attendant ejection of As into the gaseous phase. Within the 693-723 K range of annealing temperature, therefore, As desorption is not yet very significant. References 10: 3 Russian, 7 Western.

2415/12947
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UDC 620.199

TRENDS IN DEVELOPMENT OF NUCLEAR PHYSICS APPARATUS AND INSTRUMENTS APPLICABLE TO ELECTROCHEMISTRY AND CORROSION STUDIES

Moscow ZASHCHITA METALLOV in Russian Vol 22, No 4, Jul-Aug 86 (manuscript received 27 Mar 85) pp 642-645

[Article by M. A. Dembrovskiy, Scientific Research Institute of Physical Chemistry imeni L. Ya. Karpov]

[Abstract] The two major instruments developed for nuclear physics research and applicable to electrochemical measurements are unicrystal gamma-spectrometers with NaI(T1) or Ge(Li) detectors. Other instruments include multicrystal coincidence spectrometers, also anti-Compton spectrometers, gamma-radiometers, and beta-radiometers. Selective gamma-radiometers particularly applicable to corrosion measurements are built in the USSR and in CEMA countries principally on the basis of CAMAC-VECTOR modules. Also available is a new generation of AI-1024-95-01/02 automatic multichannel amplitude analyzers. An important contributing factor in the development of these instruments is the state of the art in large-scale integration and the availability of high-speed microcomputers such as the "Elektronika-60" with large memory. Digital techniques facilitate measurements of one-shot and transient or fast processes, with the aid of a PI-50-1 pulse potentiometer and possibly using a DZ-28 microcomputer. Autoradiographic techniques are improved by use of image analyzer such as the IBAS (FRG). Nuclear-gamma-resonance instruments such as Mossbauer spectroscopes are also useful for corrosion measurements. All this apparatus should be considered and the most appropriate instrument selected where electrochemical and corrosion data cannot be obtained by any conventional method. References 20: 18 Russian, 2 Western.

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UDC 539.4.015.2

HEAT RESISTANCE OF GAS-TURBINE BLADES WITH PROTECTIVE COATINGS

Kiev PROBLEMY PROCHNOSTI in Russian No 5, May 86 (manuscript received 14 Nov 83) pp 45-50

[Article by A. P. Voloshchenko, G. N. Tretyachenko, L. B. Getsov, B. M. Zinchenko, I. S. Malashenko and N. V. Kondakova, Leningrad "Proletarian Plant" Association, Leningrad; Electric Welding Institute and Strength Problems Institute, UkSSR Academy of Sciences, Kiev]

[Abstract] A test-stand study of heat-resistant coatings on gas-turbine blades in a corrosion medium was made, this being the most reliable method of evaluating their thermal fatigue strength under such conditions. Blade models made of EP220VD, EP539VD, EP539LM, ZhS6U steels were, after standard heat treatment and then mechanical surface treatment, coated with Co-Cr-A1-Y alloy by the electron-beam process or with A1-Si alloy by the slip-casting process. After subsequent annealing at 1040°C or 950°C respectively, metallographic examination revealed that the thickness of Co-Cr-A-Y coatings was uniform within at least 70%, in some cases even within 90%, and the thickness of A1-Si coatings was nonuniform with an up to 3:1 increase from front edge to back edge of a blade. The blades were tested in 163 s long 850 ⇄ 100°C temperature cycles under a static tensile stress of 240 MPa, simulating start-up transients, in a gas stream of combustion products of kerosene with a 0.15% sulfur content. The results indicate that Co-Cr-A1-Y coatings are more effective, especially on ZhS6U steel, although their annealing at 1040°C causes structural changes detrimental to the blade life under the given conditions. It therefore is necessary to modify the annealing process. In all cases cracks originated in the coating, surprisingly also in the Co-Cr-A1-Y coating and in this case probably as a result of corrosion rather than of stress differences, before propagating into the base metal of a blade. References 4: all Russian.

2415/12947
CSO: 1842/234

UDC 621.165

PREDICTING LIFE OF RUNNER BLADES WITH EROSION-RESISTANT COATINGS IN TURBO-MACHINES UNDER HIGH-VELOCITY DRIP-IMPACT LOAD

Kiev PROBLEMY PROCHNOSTI in Russian No 5, May 86 (manuscript received 10 May 84) pp 50-54

[Article by I. P. Faddeyev and A. V. Lagerev, Leningrad Polytechnic Institute, Leningrad]

[Abstract] The performance of erosion-resistant coatings on turbine runner blades under a drip-impact load is analyzed on the basis of wave mechanics covering three zones and involving the acoustic properties of the coating-sublayer system. Both the coating material and the blade material in the surface sublayer are assumed to be homogeneous and isotropic, the impedance of the coating layer being either higher or lower than that of the blade surface sublayer and the wave propagation pattern developing accordingly. The state of stress is calculated, taking into account diffraction as well as reflections and refractions of shock waves. The problem is solved analytically for a monodisperse stream of liquid drops and the results are then extended to a polydisperse one. The fatigue crack incubation period is an indicator of fracture development and blade life in each case. References 6: 4 Russian, 1 Polish (in Russian translation), 1 Western (in Russian translation).

2415/12947
CSO: 1842/234

UDC 669.76:621.315:546.23

STRUCTURE AND THERMOELECTRIC PROPERTIES OF OBLIQUELY DEPOSITED Bi FILMS

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 22, No 6, Jun 86 (manuscript received 22 Aug 83) pp 938-941

[Article by G. A. Ukhlinov, Z. Ya. Kosakovskaya and V. N. Vigdorovich, Moscow Electronic Engineering Institute]

[Abstract] Bismuth grains with a grain orientation slanting away from the normal to the substrate surface were produced in an experimental feasibility study by oblique vacuum evaporation. Microstructural examination of up to 100 nm thick films under a UEMV-100K scanning electron microscope revealed a structure almost identical to that of such films deposited on horizontal substrates, namely polycrystalline with a weak [0001] orientation relative to the normal. Microstructural examination in a DRON-2 x-ray diffractometer with an FeK_{α}-radiation source revealed a similar orientation also in up to 0.2 μm thick films. The slant angle of the crystallographic [0001] axis was found to increase with increasing substrate inclination angle, but much slower and the crystallographic (0001) plane limiting it to a maximum 12°.

Measurements of the thermal emf revealed that the Seebeck coefficient, -62 mV/K and isotropic in a plane parallel to the substrate surface in normally deposited films, was anisotropic in obliquely deposited films. As the substrate inclination angle was increased, the magnitude of the Seebeck coefficient increased in the direction parallel to the projection of the molecular beam onto the substrate surface and remained almost constant in the transverse direction. As the film condensation temperature was increased, this anisotropy first became somewhat stronger and then weaker till it almost vanished after condensation at a temperature above 80°C. Meanwhile, the transverse specific thermal efm (mV·cm/W) increased with increasing substrate inclination angle to a maximum at an inclination angle of 75° and decreased with increasing film condensation temperature but increased with increasing film condensation rate. References 4: all Russian.

2415/12947
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UDC 546.832+546.832.4-31):539.216.2

STRUCTURE OF THIN Hf AND HfO_2 FILMS ON Si SUBSTRATES

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 22, No 6, Jun 86 (manuscript received 28 Sep 84) pp 963-965

[Article by V. A. Gurtov, A. V. Kuznetsov and Ye. A. Repnikova, Petrozavodsk State University imeni O. V. Kuusinen]

[Abstract] Thin metallic Hf films were deposited on Si substrates and then oxidized into thin HfO_2 films, for an x-radiographic structural and phase analysis. Wafers of KEF-7.5 silicon with a [100] orientation were chemically pretreated, whereupon Hf films were deposited on them by cathode sputtering under 15 kV at a rate of 100 Å/min to a thickness of 700 Å in an atmosphere of spectrally pure Ar under a pressure of 0.04 Pa. These films were then oxidized by galvanostatic anodizing at a current density of 3 mA/cm² in an aqueous solution of oxalic acid and ethylene glycol. Complete oxidation within 25 min was registered by a change in the capacitance-voltage characteristic from that of an initial MOS structure. Microstructural and phase analysis in a DRON-3.0 x-ray diffractometer with a MoK_α-radiation source and a pyrolytic graphite crystal for monochromatization, in a DRON-1 x-ray diffractometer with a CuK_α-radiation source and a bent quartz crystal for monochromatization and in an RKD photographic camera with Cr-line red light revealed monoclinic and tetragonal HfO_2 with the fraction of monoclinic phase gradually increasing during the oxidation process. References 6: 3 Russian, 3 Western (2 in Russian translation).

2415/12947
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UDC 621.791.052:620.17

PHYSICO-MECHANICAL PERFORMANCE INDICATORS OF SPUTTERED COATINGS ON AUTOMOBILE PARTS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 7, Jul 86 pp 18-20

[Article by V. A. Kakuyevitskiy, candidate of technical sciences, A. I. Zverev, candidate of technical sciences, V. Kh. Kadyrov, candidate of technical sciences, G.G. Pokladiy, candidate of technical sciences, V. P. Smolinskiy, engineer, V. A. Panchenko, engineer, and I. P. Trubachev, engineer, State Design and Scientific Research Institute for Automobile Transport (Gosavtotrans NII projekt), Kiev]

[Abstract] A study of sputtered coatings on various automobile parts was made for a determination of their effect on fatigue and wear resistance under simulated real operating conditions. Specimens and actual parts of normalized St45 carbon steel, SCh120 gray iron, VCh50-2 high-strength cast iron, normalized 40Cr alloy steel as reference material, and a high-tin aluminum shoe were surface-treated with corundum and then sputter-coated using Dnepr automatic coating equipment. Coatings of Al_2O_3 powder, Al_2Ni_3 powder, NiFe+ Al,B alloy powder NZhL-1, and NiCr16Si3-R4 powder were compared in cyclic flexure, in sliding friction with lubricant (AS-8 oil + 1% abrasive TiC powder) under 6.75 MPa or 9 MPa pressure and dry under 0.75 MPa pressure, in fretting, and with cup seals. The results indicate that Al_2O_3 coating does not lower the fatigue resistance of normalized St45 carbon steel and of VCh50-2 cast iron for crankshafts in ZMZ-53 automobiles, while NZhL-1 coating increases it by up to 30%. All coatings improve the wear resistance, Al_2O_3 coatings most appreciably. Engineers V. I. Yakushev, Ye. F. Grechishkin, and V. A. Smirnov participated in the study. References 3: all Russian.

2415/12947
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UDC 621.793.621.9.044.2:539.016

PROPERTIES OF SPUTTER COATINGS FOR HIGHER WEAR RESISTANCE OF COUPLING MACHINE ELEMENTS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 7, Jul 86 pp 20-21

[Article by V. M. Temkin, engineer, V. N. Vlasenko, engineer, B. A. Podolskiy, candidate of technical sciences, and T. P. Baldina, engineer, Ukrainian Polytechnic Correspondence Institute]

[Abstract] A study of sputtered low-wear coatings on coupling machine elements was made for a determination of their properties which would allow the replacing of structural alloy steel with structural carbon steel for such elements. Two coating materials were tested, mechanical WC+ Ni mixture VN-20 and nichrome+ Al,B alloy NKhL-1. Their performance on $12CrNi3N_2$

high-cost steel was compared with their performance on St3 low-cost carbon steel. They were tested for wear in sliding friction of brake shoe against disk at a velocity of 1.308 m/s, after microhardness measurement. Histograms of mass wear, volume wear, and linear wear rate with and without coating indicate that coating reduces wear by one order of magnitude. The dependence of the friction coefficient on the normal compression load has also been established, and found to be analogous for both coating materials. As the pressure increases, the friction coefficient first increases normally, then decreases to a minimum because of plastic deformation, and again increases because of seizure. The results indicate that VN-20 coating has more microhardness, a higher wear resistance, and a stronger bond to steel, but NKhL-1 coating has better antifriction and run-in characteristics. They also indicate that coating with these materials allows substituting carbon steel for alloy steel. References 3: all Russian.

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CSO: 1842/245

UDC 621.357.1:546.261

PROPERTIES OF Mo_2C COATINGS ON VARIOUS MATERIALS

Moscow ZASHCHITA METALLOV in Russian Vol 22, No 4, Jul-Aug 86 (manuscript received 26 Nov 84) pp 564-566

[Article by V. I. Shapoval, Kh. B. Kushkhov, V. V. Malyshev, P. V. Nazarenko and N. P. Baydan, General and Inorganic Chemistry Institute, UkSSR Academy of Sciences]

[Abstract] A study of Mo_2C coatings on graphite, Cu, Ni, Mo, W, St3 and St45 carbon steels was made for the purpose of determining their mechanical and electrochemical properties. Such coatings were produced by electrolysis in an ionic melt, with codeposition of Mo and C reacting to form a continuous carbide layer and simultaneous reduction of oxygenic ions at a temperature of 800-900°C and at a cathode current density of 0.02-0.1 A/cm^2. Examination under MBS-9 and "Neophot-21" optical microscopes revealed a light-gray fine-crystalline continuous deposit. Phase analysis in a DRON-2 x-ray diffractometer with FeK_α-radiation and CuK_α-radiation sources revealed intense Mo_2C lines. Coating thickness was measured with a 2IGM multiturn indicator and was monitored on cross cuts under a microscope. Bond strength was estimated on the basis of qualitative tests: St3 steel strips were bent 180° till fracture, nickel wires were wound on a rod, St45 steel bars were quenched from 850°C and then criss-cross scratched with a tungsten needle. Microhardness measurements revealed hardening to 1800-1900 kgf/mm^2 at the coating-substrate interface, as a result of interdiffusion. Existence of a diffusion zone was confirmed by x-ray microspectral analysis with an MS-46 "Cameca" electron probe and by microstructural examination under a "Stereoskom S-4" scanning electron microscope. The corrosion rate was measured in 38.3 wt.% HCl, 95.1 wt.% H_2SO_4, and

and 85.9 wt.% H_3PO_4 concentrates. The wear rate under a load of 5 mPa in transformer oil was measured over a wide range of sliding velocity. Wear of Mo_2C coating on St45 steel against bare St45 steel was compared with wear of bare steel against steel and found to be 5-7 times lower. It was also compared with wear of bare St45 steel and of TiNx, VNx nitride coatings as well as boride coating on St45 steel against VK-2 tungsten-cobalt alloy. The results indicate excellent performance of galvanic Mo_2C coating. References 4: all Russian.

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MICRODISTRIBUTION OF GALVANICALLY DEPOSITED GOLD

Moscow ZASHCHITA METALLOV in Russian Vol 22, No 4, Jul-Aug 86 (manuscript received 25 Mar 85, after revision 11 Jun 85) pp 625-627

[Article by G. I. Yefimova, Ye. A. Yefimov and L. N. Peresvetova]

[Abstract] A study of submillimeter thick Au films galvanically deposited on semiconductors or dielectrics was made, an essential requirement being a uniform distribution over the substrate surface with minimum lateral buildup. Four electrolytes for soft gold plating were experimentally evaluated and their equalizing capability determined in deposition of 10-12 μm thick Au films at a temperature of 65±2°C and at two current density levels, 40 A/m² and 100 A/m², with identically intense stirring of the fresh electrolyte in each case. These electrolytes were: 1. 10 g/l $KAu(CN)_2$ + 70 g/l $K_3C_6H_5O_7.H_2O$ + 30 g/l $C_6H_8O_7.H_2O$ (pH= 5.5), 2. 10 g/l $KAu(CN)_2$ + 60 g/l $(NH_4)_2HPO_4$ + 30 g/l $NH_4H_2PO_4$ + 3 g/l $K_2SO_3.2H_2O$ + 0.008 g/l $T1NO_3$ (pH= 5.5), 3. 10 g/l $Na_3[Au(SO_3)_2]$ + 75 g/l Na_2SO_3 + 40 g/l $Na_2SO_4.10H_2O$ + 35 g/l H_3BO_3 + 40 g/l $Na_2EDTA.2H_2O$ (pH= 9.0), 4. 10 g/l $K_6[(AuSO_3)_2EDTA]$+100 g/l $Na_2EDTA.2H_2O$ + 40 g/l K_2SO_4 + 40 g/l K_2HPO_4 + 6 g/l "VZ" (gold equalizing) additive (pH= 9.0). EDTA= ethylene-diamine tetracetate. Gold films were deposited from each electrolyte on 1 μm thick photolithographic microcircuit chips in the form of 50 μm long and 20 μm wide strips 50 μm apart. Local thickness and lateral buildup were measured under an MII-4 optical microscope within ±0.3 μm accuracy. The results indicate that electrolytes 1,2,3 produce a lateral buildup and electrolyte 4 produces a lateral taper. The buildup decreases with decreasing current density and with electrolyte 2 can be reduced to zero by reducing the current density to 30 A/m². The equalizing power on the basis of a sinusoidal surface microrelief was measured with a P-252 profilograph-profilometer under 4000x magnification in the normal plane. Electrolyte 4 was found to have the highest equalizing power. It also produces the hardest Au deposit, with a microhardness of 1200-1250 mPa in a PMT-3 tester with a 10 g load. After a period of 3 months it still produced a 998.6 proof Au deposit, thus being the best of all four electrolytes. References 2: 1 Russian, 1 Western.

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ANODIC BEHAVIOR OF Au IN CITRATE SOLUTION FOR SOFT GOLD PLATING

Moscow ZASHCHITA METALLOV in Russian Vol 22, No 4, Jul-Aug 86 (manuscript received 11 May 85, after revision 16 Sep 85) pp 627-629

[Article by Ye. A. Yefimov and T. V. Gerish, Moscow Evening Metallurgical Institute]

[Abstract] A study of soft gold plating with the electrolyte 0.04 M $KAu(CN)_2$ + 0.4 M $K_3C_6H_5O_7$ + 0.1 M $C_6H_8O_7$ + 0.2 M K_2HPO_4 (pH= 6.0) was made for the purpose of determining the anodic behavior of Au in the presence of citric acid $C_6H_8O_7$ and its ion $C_6H_5O_7^{3-}$. Oxidation of the $C_6H_5O_7^{3-}$ anion was measured by vanadate titrimetry on a 1 A·h basis. The current yield of this oxidation was evaluated for one-electron and two-electron reactions, also from the current yield of anodic Au dissolution and O_2 evolution. Anodic polarization curves were plotted with the total $C_6H_5O_7^{3-}$ content varied from 0.25 M to 0.63 M in 0.12-0.13 M steps, with an Au electrode and also with a Pt electrode. The slope of log j — log C curves (j- density of oxidation current, C- anion concentration) subseqeuntly plotted at two potentials, 1.65 V and 1.80 V, indicates a first-order reaction. These data indicate that the $C_6H_5O_7^{3-}$ anion depolarizes the Au electrode, while its oxidation becomes slower as its concentration decreases during electrolysis. As the anode (Au electrode) potential is raised, the oxidation rate increases to a peak at E= 1.1 V and then dips before increasing further. No such peaking occurs at a Pt electrode and in the supporting electrolyte. According to ellipsometric data, at an anodically polarized Au electrode forms first a surface layer of adsorbed O_2 so that oxidation of the anion is impeded and then under a higher potential forms an oxide phase monolayer which allows oxidation of the anion to resume. References 8: 6 Russian, 2 Western.

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UDC 621.762:669.018

COMPACTION KINETICS DURING HOT PRESSING OF COMPOSITE MATERIAL BASED ON HARD ALLOY

Kiev POROSHKOVAYA METALLURGIYA in Russian No 6, Jun 86 (manuscript received 17 Sep 85) pp 20-24

[Article by M. S. Kovalchenko, D. Kh. Bronshteyn, E. S. Simkin and N. V. Tsypin, Institute of Materials Science Problems, UkSSR Academy of Sciences]

[Abstract] A composite material consisting of the VK6 (W-Co) hard alloy as matrix and green SiC as filler, in lieu of natural or synthetic diamonds, was hot pressed in an experiment with a hydraulic press specially designed by the Superhard Materials Institute (UkSSR Academy of Sciences). The mold was made of electrode graphite and the external pressure was maintained constant by an oil feed from a dashpot. The purpose was a study of the compaction kinetics at temperatures covering the 1373-1673 K in 50 K steps under pressures of 2.45 - 4.9 - 9.8 - 14.7 MPa. Pressure was applied after heating to the given temperature. The results of measurements, compaction curves of density as function of time, indicate a saturation after 2-6 min depending on the temperature and the pressure. The results agree closely with calculations based on the thermodynamic theory of three-dimensional flow for a porous viscous material and applicable data on the compaction activating energy. Accordingly, the flow is nonlinear with a nonlinearity index n=4 at lower temperatures of 1373-1473 K under pressure and compaction ceases upon buildup of a counterpressure in the pores at higher temperatures of 1523-1673 K. References 6: 5 Russian, 1 Western (in Russian translation).

2415/12947
CSO: 1842/238

UDC 532.696

FORMATION OF BRITTLE PHASES AT INTERPHASE BOUNDARY BETWEEN ALUMINUM MELT AND BORON FIBER OR BARRIER COATING ON BORON

Kiev POROSHKOVAYA METALLURGIYA in Russian No 6, Jun 86 (manuscript received 16 Dec 83) pp 59-63

[Article by T. A. Chernyshova, A. V. Rebrov, S. O. Gevlich and M. I. Tylkina, Metallurgy Institute, USSR Academy of Sciences]

[Abstract] A study of boron-aluminum composite material produced by the liquid-phase process was made, particularly of the reaction products at the interphase boundary between the aluminum melt and either a boron fiber or a barrier coating (B_4C, SiC) on boron. The material was produced from boron fibers 140 μm in diameter, bare or with 2-5 μm thick B_4C or SiC coatings, and AD1 commercial aluminum. Fibers were dipped in the aluminum melt at various temperatures covering the 680-800°C range and held immersed for various lengths of time, whereupon the aluminum was crystallized on the surface of fibers for shielding the reaction products from air. For microstructural examination and for Debye phase analysis by x-ray diffraction and electron diffraction, the crystallized aluminum was dissolved separately in aqueous 10% HC1 solution, in aqeous $CuC1_2$+ NH_4C1 solution, and in anhydrous $CH_3COOC_2H_5$+ Br+ KBr. Phase analysis revealed borides $A1B_2$ and $A1B_{12}$ at the A1-B interphase boundary and in the A1-B/B_4C system, also carbide $A1_4C_3$ in the A1-B/B_4C system, and only carbide $A1_4C_3$ in the A1-B/SiC system. According to the results of chemical analysis, B_4C barrier coatings were biphasal with up to 20% free carbon and SiC barrier coatings were monophasal. In both systems with barrier coatings and liquid aluminum at 770°C or higher temperature, moreover, $A1_4C_3$ was found to build up first very fast by reaction of aluminum with free carbon and then much slower but continuously. Addition of 6% Mg to aluminum changed not only the reactions at the interphase boundary but also the flexural strength of coated fibers, increasing that of B/B_4C fibers and decreasing that of B/SiC fibers after removal of the A1-Mg alloy. References 9: 5 Russian, 4 Western (1 in Russian translation).

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CSO: 1842/238

UDC 620.195

EFFECT OF ALLOYING SUPERFERRITIC HIGH-CHROMIUM STEEL WITH Mo OR Ti ON ITS MECHANICAL AND CORROSION CHARACTERISTICS

Moscow ZASHCHITA METALLOV in Russian Vol 22, No 4, Jul-Aug 86 (manuscript received 11 Jul 85) pp 517-521

[Article by N. D. Tomashov, G. P. Chernova, A. D. Goronkova, F. L. Levin, O. D. Agakishiyev and S. A. Golovanenko, Physical Chemistry Institute, USSR Academy of Sciences]

[Abstract] A study of 01Cr25TiNb steel of the superferritic class with extra-low C,N_2 content (C+ $N_2 \leq 0.02\%$) was made for the purpose of determining the effect of additional 1-4% Ti or 1-2% Mo on its mechanical and electrochemical characteristics. Batches of pure steel were remelted and alloyed in a "Baltzers" vacuum-induction furnace. Billets of alloyed steel were forged and rolled into 5 mm thick strips which, after this hot plastic deformation at temperatures of 1050-800°C, were annealed at 850°C for 30 min and then cooled in water. Specimens of pure steel and of alloyed steel, in the initial state and after heat treatment equivalent to welding, were tested for mechanical characteristics including toughness and brittleness of fracture. Both corrosion potential and corrosion rate were measured in 5-40% H_2SO_4 and in 3-10% HCl at various temperatures up to 50°C, also in 10% $FeCl_3$ at 25°C. The results indicate that addition of 1% Ti improves the mechanical characteristics, including a higher resistance to brittle fracture, while addition of 1-2% Mo does not. Addition of 1-2% Ti or 1-2% Mo lowers the corrosion rate in H_2SO_4 solution and in NaCl solution, addition of 1% Ti or 1-2% Mo lowers the rate of pitting corrosion in $FeCl_3$ solution, but addition of 3-4% Ti increases the rate of all corrosion and more so in more aggressive media. Low content of interstitial C (0.011% or less) and N_2 (0.006% or less), also S and Mn, is an essential factor ensuring high resistance to general corrosion as well as to intergranular and pitting corrosion. Titanium, moreover, forms with excess C and N_2 corrosion-resistant carbide and nitride inclusions. References 13: 7 Russian, 6 Western.

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UDC 620.194

ELECTROCHEMICAL CHARACTERISTICS OF SUPERFERRITIC STEEL 01Cr25TiB ADDITIONALLY ALLOYED WITH Mo OR Ti

Moscow ZASHCHITA METALLOV in Russian Vol 22, No 4, Jul-Aug 86 (manuscript received 1 Aug 85) pp 522-527

[Article by O. D. Agakishiyev, N. D. Tomashov, G. P. Chernova and O. A. Semenova, Physical Chemistry Institute, USSR Academy of Sciences]

[Abstract] A study of superferritic steel 01Cr25TiNb ($\leq$ 0.02% C+ N_2, 0.19% Ti, 0.17% Nb) was made for the purpose of determining the effect of additional alloying with 1-4% Ti or 1-2% Mo on its corrosion resistance in 1.0 n H_2SO_4, in 1.0 n NaCl, and also in 0.5 n NaCl, at room temperature of 25°C. The approximately 3.5 cm² surface area of rectangular specimens was polished with emery paper, degreased with acetone, rinsed with distilled water, and dried with filter paper. Anodic polarization curves were plotted by potentiostatic measurement, holding for 30 min at each point; cathodic polarization curves were plotted by potentiodynamic measurement at a rate of 2.4 V/h. These measurements were made under free access to air with either natural convection or stirring of the electrolyte. The results indicate that 1-4% Ti or 1-2% Mo decreases the anodic dissolution current in 1.0 n H_2SO_4 throughout both active and passive ranges, with the overpassivation potential shifted in the positive direction by Ti and in the negative direction by Mo. Addition of 1-2% Ti or 1-2% Mo shifts the pitting potential in NaCl solutions into the anodic range and thus increases the resistance to pitting corrosion here. References 12: 7 Russian, 5 Western.

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UDC 620.193.4

PROTECTIVE CHARACTERISTICS OF METAL AND METAL-POLYMER COATINGS

Moscow ZASHCHITA METALLOV in Russian Vol 22, No 4, Jul-Aug 86 (manuscript received 12 Apr 84, after revision 4 May 85) pp 551-554

[Article by I. L. Kupriyanov, M. N. Korotkina, V. S. Ivashko, A. A. Verstak and V. Sh. Sokhadze, Belorussian Republic Scientific-Production Association of Powder Metallurgy]

[Abstract] A study of protective metal and metal-polymer coatings was made for the purpose of comparing their performance in an aggressive medium such as an aqueous 10% $(NH_4)_2SO_4$ solution. The materials selected for metal coatings were Cr18Ni9TiA1 stainless steel, aluminum, and zinc. These coatings, 0.1-0.4 mm thick, were deposited on one side of 1.5 mm thick specimens of St3 carbon steel 15x50 mm² in area. They were deposited by two methods, electric-arc metallization and gas-flame spraying. Polymer coatings up to 0.2 mm thick were deposited on the metal coatings, coatings of pentaplast with a hot gas

stream and various coatings of high-density polyethylene with different modifiers in a turbulized vibration bed. Coatings of the LN-polyethylene modification for agricultural equipment were heat treated for 60 min and then cooled at a rate of 180°C/min. Coatings of the general-purpose Ch-polyethylene modification were heat-treated for 60 min (Ch-60) and 90 min (Ch-90) and then cooled at a rate of 180°C/min or for 100 min (Ch-100) and then cooled at a rate of 2°C/min. Electrochemical measurements included determination of both corrosion potential and corrosion rate with a PI-50-1 potentiometer and a YaSE-2 cell with cathode region and anode region separated by a glass filter. They were supplemented with measurements of specific area nad porosity as well as electrical resistivity characterizing the state of coatings. Potentiodynamic polarization curves were plotted at a rate of 1 mV/s. Porosity of coatings was determined from the constant-potential current density corresponding to dissolution of the base steel, namely as the ratio of this current density to that for a reference specimen of the base steel after surface treatment with an abrasive jet. The results indicate that Cr18Ni9TiA1 coatings are more porous when deposited by gas-flame spraying and less porous when deposited by electric-arc metallization, the porosity decreasing as the thickness increases. They also indicate that metal-polymer coatings remain adequately protective when the film of LN (stabilized) high-density polyethylene ceases to be continuous, the Cr18Ni9TiA1 coating underneath being evidently impregnated with polymer material. References 2: both Russian.

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UDC 620.197.3

CORROSION INHIBITOR TAL-3 WITH LOW FREEZING POINT AND SOLUBLE IN HYDROCARBONS

Moscow ZASHCHITA METALLOV in Russian Vol 22, No 4, Jul-Aug 86 (manuscript received 5 May 85) pp 606-609

[Article by S. A. Nesterenko, V. I. Sorokin and O. V. Naumenko, Kiev Polytechnic Institute]

[Abstract] A corrosion inhibitor TAL-3 containing a phenol group has been developed at the Kiev Polytechnic Institute jointly with the Bashkir Scientific Research Institute of the Petroleum Industry for protection of ferrous metals in two-phase media with hydrocarbons + water. The inhibitor begins to freeze at $\leq$ -30°C, flashes at 60°C, kindles at 70°C, and ignites spontaneously at 218°C. Its kinematic viscosity at 20°C is 50 centistokes. It is highly soluble in hydrocarbons and in alcohols, weakly soluble in aqueous salt solutions. It shifts the static potential of 08kp steel in the positive direction by 20-85 mV, depending on the temperature, and thus prevents anodic dissolution. Both cathode and anode currents become minimum when the inhibitor concentration reaches 100 mg/1, further increase of the inhibitor concentration causing a slight increase of either current to cover reduction or oxidation of additives. The inhibitor was tested alone and with a nonionogenic surfactant such as 44-11 disolvane, in laboratory experiments simulating dynamic

conditions in a pipeline with fluid flowing at a velocity of 0.3-0.5 m/s. With a surfactant which ensures a more uniform distribution of inhibitor between hydrocarbon and water phases, 200 mg/l of TAL-3 protects 08kp steel against corrosion 92% effectively when oxygen is in the stream and 99% effectively when H_2S is in the stream. References 8: all Russian.

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UDC 678.026:532.1

INHIBITING ACTION OF CAOUTCHOUCS SOLUBLE IN OIL

Moscow ZASHCHITA METALLOV in Russian Vol 22, No 4, Jul-Aug 86 (manuscript received 6 Sep 85) pp 609-611

[Article by Yu. V. Yemelyanov, and E. N. Anokhina, All-Union Scientific Research Institute for the Protection of Metals from Corrosion]

[Abstract] A study of nonpolar caoutchoucs soluble in transformer oil was made for a determination of their effectiveness as corrosion inhibitors. Liquid polyisobutylene, isobutylene oliopmers with carboxyl or hydroxyl end groups, polybutadiene and its oligomers with hydroxyl groups were each tested on St3 carbon steel in 3% NaCl electrolyte. The inhibitor concentration in transformer oil was 4% in each case. The cylindrical steel electrode had been cleaned, degreased with an organic solvent, and soaked for 1 h in inhibitor solution. Anodic and cathodic polarization curves were plotted by the potentiostatic method; the corrosion rate was measured by weighing. The positive shift of the corrosion potential by each inhibitor was measured, plain oil film without inhibitor having been found to hardly shift this potential at all. Most of the inhibiting action was found to occur within the first hour. The results reveal that inhibitors with hydroxyl groups are more effective, most effective being the inhibitor with the largest number of these groups in its molecular structure. References 2: 1 Russian, 1 Western.

2415/12947
CSO: 1842/252

SECONDARY RESOURCE AND INDUSTRIAL WASTE UTILIZATION

Baku BAKINSKIY RABOCHIY in Russian 15 May 86 p 2

/Article by Doctor of Economic Sciences N. Nabiyev: "Is There a Metal Shortage or Has It Been Created by the Inertia of Mismanagement"/

> /Text/ The problem of drawing secondary resources into production cycles is acquiring all the greater significance at the present time. It is written in the basic directions for the economic and social development of the country:"to significantly improve the use of secondary resources and industrial waste, develop production capacities to treat them, improve the organization for collecting raw materials, including from population, and strengthen the material and technical base of procurement organizations."
>
> BAKINSKIY RABOCHIY has touched on this major problem many times, recounting, in particular, the experience of the Ukrainian SSR, approved by the Politburo of the CPSU Central Committee, on the skillful utilization of secondary resources. Today we are once again returning to this theme, by publishing an article by Doctor of Technical Sciences N. Nabiyev, a department chief in the Commission for the Study of the Productive Forces and Natural Resources of the Azerbaijan SSR Academy of Sciences.

The availability of mineral raw material and power fuel sources has played a key role in past years in locating key sectors of industry and developing them in Azerbaijan. However, the situation has now changed somewhat, but in spite of this, a radical change in attitude toward secondary resources and industrial waste has still not occurred.

What do economic managers as well as production workers complain about most often? About the shortage of metal, sheet rolled metal, and pipes. Their lack is often an argument to justify the errors of these people. This argument often "works," for a shortage of ferrous metals and rolled metal is considered usual. Things have come to such a point that this argument was used by the metallurgists of the Azerbaijan Tube-Rolling Mill at a meeting of the party economic aktiv they recently held to examine the condition of production in light of the critical remarks of comrade M. S. Gorbachev, about the Sumgait

enterprise, which were expressed at a meeting with Togliatti laborers. I will remind you that it was said at the meeting that, because of a metal shortage, equipment downtimes in the first quarter amounted to 300 hours, and 10,000 tons of pipe could have been manufactured during this time.

What is there to object to here? The main objection is that it turns out that such quotations can be calmly used, while the republic disposes of enormous reserves for the development of that same rolled pipe production and, on a wider scale, also for supplying it to metallurgy, machine building, and metal machining organizations. They talk quite frequently about a metal shortage at the Azerbaijan Pipe Plant. But let's examine what its material base must be. It is scrap metal and, properly, an enterprise was built in Sumgait to process it in the Transcaucasus rather than carry it to the central regions of the country. It is now worth strolling through the territory of any industrial region of Baku and its vicinity. Scrap metal will be found literally everywhere. There is not enough newspaper space for even a single listing of its sources. But, evidently, some at least must be named for clarity's sake. Inactive wells, with the metal structures of derricks and pumping jacks over them, have been abandoned after dozens of years of operation of the oilfields. Underfoot at these same oilfields are bent, warped pipes and parts of abandoned piping. How much abandoned structures, tanks, written-off machines, and equipment are still scattered about here and there? All of this is scrap that is needed by the metallurgists of the Azerbaijan Pipe Plant.

Secondary resource reserves are numbered in the millions of tons in the republic. These resources are at times expensive. Indeed, dozens of kilometers of trolley lines have simply been left under the asphalt after many routes have been closed down. How many railroad tracks lie where no one needs them? This is not simply scrap--it is expensive alloy steel. It can be found anywhere: at railroad stations, in fields, at construction sites where parts of metal structures are quite frequently simply buried in the ground. Even if the fragments are not made whole again, the open hearth furnaces need them, for with the skillful utilization of such resources, the metallurgists will have sufficient reserves for years. I will emphasize--for smelting especially high-quality steel.

We have special organizations to collect and procure scrap metal--Vtorchermet /State Trust for the Procurement and Processing of Secondary Ferrous Metals/ and Vtortsvetmet/State Trust for the Procurement and Processing of Secondary Nonferrous Metals/. As a matter of fact, both organizations see their task as only to collect scrap metal at enterprises where it is formed during production. That is it. They have enough of it to fulfill the plan. Who then is concerned with collecting the scrap that we have talked about? Who must be interested in secondary resources of the so-called public and domestic sectors? More simply put, who will collect the discarded heat radiators which earlier were in apartments and institutions, the various motors, the thousands of tons of scrap metal which are unavoidably being produced in the large densely populated cities? Under today's guidelines for Vtorchermet and Vtortsvetmet work, it turns out that no one will. This must not be. The first step here, I think, is that the very organizations concerned with the collection and procurement of scrap metal must do this, as well as those who control their work.

There are such concepts as "plant" and "city deposits." They unite the sources of scrap metal that we are speaking about in this article. Let's be realists; they will not be "developed" by the forces of the specialized organizations alone. An interested attitude on the part of local soviets and public organizations is very important here. Naturally, it does not befit the metallurgists, both of the Azerbaijan Pipe Plant and the other enterprises where scrap is smelted, to stand aloof.

However, unsolved problems in using secondary resources for the metallurgical and machine building industries are not only in this area. We have taken for granted the reliance on the shipment of the basic raw materials for them. Of course, they are spending enormous funds and transportation is being loaded to the limit. However, the situation will change if their own reserves, which are available in sufficient quantity, are managed wisely. The total utilization of the iron ore of Dashkesan and the industrial waste of the Azerbaijan Mining and Concentration Combine must also play a significant role here. Strictly speaking, such an approach is dictated by specific conditions. It is worth stressing that the ore in this region is complex in composition. In addition to iron, it contains cobalt and components necessary for the different raw materials of the construction industry and agricultural production.

The use of the industrial waste of ferrous metallurgy has not been efficiently set up in the republic. Some 30 million tons--that is the total amount of Azerbaijan Pipe Plant slag which was accumulated at dumps dozens of meters from the enterprise, and the so-called "concentration tails" of the Azerbaijan Mining and Concentration Combine. By our calculations, they contain approximately 6.2-6.5 million tons of iron. Thus, it is urgently necessary to begin the total utilization of wastes as soon as possible. By these same calculations, this will yield 4.5-5 million tons of cast iron.

An important facet of this work is the solution of the ecological problems through the skillful use of secondary resources and industrial waste. The dumps of the Azerbaijan Pipe Plant and the Mining Concentration Combine cover more than 60 hectares. It is absolutely necessary to also clear them out in the interests of agricultural production. Subsidiary forms can be located here which can receive heat, power, and steam from the ferrous metallurgy enterprises. The total value of the land covered by the plant and ferrous metallurgy combine dumps exceeds a million rubles. Unfortunately, we will not be able to calculate exactly what sites covered by the industrial waste and scrap metal of enterprises of other sectors and oil industries have fallen out of circulation. One thing is clear--we are talking about tens of millions of rubles in losses. It must be kept in mind that the soil under such heaps is ruined and the ecological conditions around them are being changed for the worst. This is also of concern.

The total utilization of secondary resources and industrial waste would permit a significant increase in the commodity production output volume of the republic's industry. It is important that a real possibility could emerge for decreasing the import of metal and rolled metal. Evidently, a clear work plan, intersectorial in nature, is first of all necessary here--work in which there must be no place for departmental barriers. Under the conditions of accelerating scientific and technical progress, it can be successfully carried out only through the precise recommendations of scientists. I feel that it is worth creating the intersectorial scientific and technical complex "Secondary Resources and Total Utilization of Raw Materials."

PREPARATORY COMMISSION DISCUSSES METALLURGICAL INDUSTRY PROBLEMS

Moscow IZVESTIYA in Russian 13 Jun 86 p 2

/Article by Yu. Grinko: "Metal of the State--Preparatory Commission on the Metallurgical Complex Meets"/

/Text/ Our country has no equal in mining iron and manganese ores and producing coke, cast iron, steel, rolled metal, steel pipes, and metal products. The USSR share of rolled ferrous metal amounts to about 20 percent of world production. The situation in this basic sector significantly determines the growth and effectiveness of national production on the whole and the defensive capability of the motherland.

How is work going in the "hot shop" of the Soviet Union? What measures must be taken for the country to obtain more high-quality metal products? What is necessary to speed up the development of the sector? Such was the range of questions which was of interest to the USSR Supreme Soviet deputies at the first meeting of the preparatory commission on the metallurgical complex. Its purpose was to discuss unresolved problems and develop recommendations to refine the indicators in the draft of the state plan for the economic and social development of the USSR in the years 1986-1990.

The chairman of the preparatory commission G. G. Vedernikov, first secretary of the Chelyabinsk CPSU obkom, conducted the meeting. Deputy chairman of USSR Gosplan/State Planning Committee/ V. A. Vanchikov and member of the USSR GKNT/State Committee of the USSR Council of Ministers for Science and Technology/ S. P. Antonov delivered reports. There was also a report by first deputy minister of USSR ferrous metallurgy L. V. Radyukevich.

You would not call the work results of metallurgists in the 11th Five-Year Plan satisfactory. In the past year alone they were 8 million tons of cast iron, 12.4 million tons of steel, almost 10 million tons of finished rolled metal, 2.3 million tons of steel pipe, and about 7 million tons of six-percent moisture content coke short of the plan.

One of the basic reasons for this lag was the disruption of capital construction plans and of the introduction of production capacities. A significant lack of balance also affected the levels for developing raw material production and subsequent metallurgical reprocessing. The tempo for retooling and modernizing enterprises has been inadequate. These, so to speak, are objective difficulties. However, many errors and careless slips have come to light within the sector itself. The quality of capital repair and technological discipline has quite often left much to be desired. Economic work in the sector slackened, which led to enormous losses. The June (1985) conference at the CPSU Central Committee on the problems of accelerating scientific and technical progress bluntly pointed out that the situation in ferrous metallurgy requires important changes. It is natural that the principle of the accelerated development of the sector was made the basis for the development of the USSR Minchermet [Ministry of Ferrous Metallurgy] draft plan for the draft plan for the 12th Five-Year Plan. The essence of it is the utmost intensification of scientific and technical progress, structural reorganization, and effective forms of control, organization and motivation of labor.

The meeting noted that the draft plan provides for widescale fixed capital replacement, the modernization of the Magnitogorsk and Kuznetsk metallurgical combines, the Zaporozhstal and imeni Dzerzhinskiy combines, metallurgical plants in the Urals, in Georgia, and many other projects. The task has been set for the radical improvement of the pattern of steel smelting production and for the significant increase in smelting in converters and electric furnaces. Steel teeming by the continuous method will double in the next five-year plan. A further increase in output and an improvement in the structure of metal production have been planned to be realized almost fully through intensive factors, without increasing the number of personnel. There will be a growth in production volume without increasing cast iron, coke and iron ore production. An increase in quality and an expanding metal products list will yield in 1990, in comparison with 1985, a savings in the national economy of about seven million tons of metal. Special importance is being attached to improving the working and living conditions of the metallurgists, decreasing onerous and labor-intensive operations, and implementing environmental protection measures.

The deputies noted that the draft plan presented for consideration had been developed in accordance with the decisions of the 27th CPSU Congress and the basic directions for the economic and social development of the country.

At the same time, many provisions of the plan became the subject of lively discussions. In this sense, the following dialog between the members of the preparatory commission and the deputy chairman of USSR Gosplan V. A. Vanchikov was revealing.

"Vladimir Alekseyevich, for many years running the sector's capital construction plans have not been fulfilled. You were not successful in assimilating four billion rubles in the past five-year plan. Is there any guarantee that the 22.5 billion rubles planned for the 12th Five-Year Plan is fully realistic?"

"The one who controls capital investments is responsible for this. The one who carries out the contract work plan..."

"But what is the role of USSR Gosplan in this case? You have a construction division and a metallurgy division. Do they control construction production? Who is charged with disruptions? How do you solve this problem?"

"The plan was correlated with the contract work volume."

"Why were four billion rubles not assimilated in the past five-year plan?"

"The activities of the contractor ministries were poorly managed."

"Who is responsible for this?"

"Among others, USSR Gosplan."

"Why 'among others'? Evidently, it has primary responsibility here--it planned what turned out to be unfulfillable."

"That which could be fulfilled was planned. The plans were approved by the USSR Council of Ministers and a session of the USSR Supreme Soviet. Gosplan does not bear responsibility for the errors of builders."

"The party has sharply criticized the existing work system and has demanded reorganizations. Today one needs to treat the matter and the country's central planning organ differently. Each one must be responsible for his entrusted sector. We have not heard yet how the assigned funds will be assimilated. And will they?"

"The year 1986 has already shown that, on the whole, the construction and installation work plan is being fulfilled. We calculate that this trend will continue."

The significant increase in capital to retool and modernize the sector's operating enterprises is pursuing the end of converting to basically new technological systems and to the latest generation of equipment which is yielding the highest effectiveness. Sectorial science has been called upon to play a large role under these conditions.

"Meanwhile," deputy V. A. Orlov, a rolling-press operator at the Zaporozhstal Metallurgical Plant imeni Ordzhonikidze, noted, "the amount of scientific research work, whose technical level would have exceeded world and domestic levels, was practically cut in half in ferrous metallurgy in the last five-year plan. Of the total number of developments introduced which were aimed at creating new equipment, only half of them were at the level of inventions."

"What is being undertaken to increase the output of sector science?" S. P. Antonov was asked this question.

"At the end of last year," the member of USSR GKNT answered, "we analyzed the work of three dozen of the sector's scientific research organizations. In accordance with the government's instructions, we checked the technical level of a number of projects, determined not only the shortcomings but also specific measures to eliminate them. USSR Minchermet appreciably strengthened

control over the fulfillment of scientific and technical programs and the formation of the subject matter plans of the institutes. The course was taken to create equipment providing a high growth in labor productivity and non-waste technologies."

The members of the preparatory commission were interested to what extent the sector's retooling program was coordinated with the subcontractors. It turns out that on the whole they had been successful in this. However, there are grounds for uneasiness. These wishes were stated: for Mintyazhmash/Ministry of Heavy and Transport Machine Building/--accelerating the delivery of six machines for the production of bent sections and machines for aluminumizing sheets, the construction of a 1500 mill for the Novolipetsk Combine; for Minelektrotekhprom/Ministry of the Electrical Equipment Industry/--the timely supply of electric furnaces and their individual elements for modernizing existing furnaces; for Minstankoprom [Ministry of the Machine Tool and Tool Building Industry/--pushing the development and manufacture of highly productive lines for trimming and stripping metal; for Minpribor/Ministry of Instrument Making, Automation Equipment, and Control Systems/--the creation of reliable systems to control technological processes. After thoroughly investigating the heart of the problems connected with the cooperation of the machine building ministries, the deputies propose to turn the attention of the permanent commission to the necessity for firm control over the fulfillment of deliveries of the cited equipment to the metallurgists.

The representative of USSR Gosbank/State Bank/ G. S. Zubkova, the deputy chief of the loan administration of the metallurgical and chemical industry, asks to speak.

"In the last five-year plan ferrous metallurgy did not fulfill tasks for bringing commodity stocks into economic circulation by 450 million rubles," she informs them. "USSR Gosbank is ceasing the granting of loans for material assets if they do not correspond with the growth of production volumes. I request that representatives of all departments pay attention to this. Then I would like to find out how USSR Minchermet intends to normalize its financial situation."

L. V. Radyukevich: "The lack of working capital and the loan liabilities amount to about one and a half billion rubles for us. We already plan to receive 150 million rubles of above-plan profit this year. We will target it to the elimination of the lack of our own working capital. What is being done for this? We are beginning a radical reorganization of economic operations in the associations and at the enterprises. Councils of enterprise directors have been held with this agenda where are economic problems requiring immediate solution have been examined."

The housing and social welfare construction program has become an object of the most intense scrutiny by the deputies.

"How much capital is being allotted for this?"

"We plan to direct 2.8 billion rubles of capital investments, of which 430 million rubles are at the expense of the enterprise funds, to build all non-productive construction projects," V. A. Vanchikov answers.

"But this is 13 percent less than in the 11th Five-Year Plan. How is that?"

"You are right. The state has given serious reproofs on this indicator of the plan. Instructions have been given to refine it. Through reducing the cost of constructing ferrous metallurgy projects, resources have to be found which will provide the introduction of housing at least at no less a level than in the last five-year plan. A minimum of 14 million square meters must be built. We have been commissioned to do a thorough study of the Leningrad method for constructing social and cultural projects: by an increase in shift work and better utilization of operating capacities there is no need to commission industrial construction projects, with the released capital investments being transferred to the construction of housing, hospitals, and kindergartens. Such proposals are being prepared."

The commission deputies have drawn up observations and suggestions reflecting a wide circle of problems connected with refining the ferrous metallurgy development program. All of them will be considered during the preparation of the resolution of the permanent commissions of the USSR Supreme Soviet on the state plan for the economic and social development of the USSR in the years 1986-1990.

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CSO: 1842/233

POOR QUALITY OF COAL MINING EQUIPMENT DISCUSSED

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 9 Jul 86 p 2

/Article: "A Machine Begins with Metal"/

/Text/ It is more and more difficult to mine famous Donbass anthracite each year. Its main reserves, though fairly large, lie today in strata less than one meter thick. Of course, a small coal piece can only be lifted from longwall, in which the miners must work stooping and maybe even lying down, with the help of compact and reliable equipment. Just such a highly productive scraper-loader, in combination with mechanized piles, was created at one time in the miners' city of Shakhty.

The scraper-loader quickly received a start in life. The best miner brigades, headed by A. Belov, A. Gatsenko and others, set a great number of records on this equipment. However, its reliability has sharply decreased in recent years. Take, for example, the Mayskaya mine. If before they routinely worked the longwall here with one scraper-loader, then now under precisely the same conditions the cutting elements of the machines are changed about four times. The chain gears work without repair for no more than a month--four-fold less than in past years. The scraper-loader and conveyor chains break down constantly. In general, they conducted a time study of the work of the miners in the mines and they were horrified. Even in advanced collectives where the operation of the scraper-loader is properly maintained, five days a month are spent on eliminating breakdowns and accidents. It is not difficult to calculate that a miner brigade is short about 200,000 tons of coal a year because of the low reliability of mining equipment alone.

The identity of the manufacturer of practically all scraper-loaders is well-known--the Shakhtinskiy Machine Building Plant of USSR Minugleprom/Ministry of the Coal Industry/. The technical equipment of the enterprise, although it does not meet modern requirements, is improving from year to year. Why then has the quality of the mining complexes and machines decreased?

"Just look at what kind of metal the Kuznetsk Metallurgical Combine is sending us," says A. Starikov, the chief of the welding preparation shop. "It is even evident to a non-specialist: multi-ton iron messes have been received. As a matter of fact, such rolled metal should be sent to a secondary raw materials facility, but it is being manufactured for dozens of years according to specifications approved by USSR Minchermet/Ministry of Ferrous Metallurgy/. The

machine builders themselves have been forced to bring the billets to the required conditions. After heating the defective rolled metal sheet whose surface is crooked beyond the permissible limit in a heat-treating furnace, the workers manually straighten it on a press. A portion of the billets, not having withstood the stress, are consigned after all to scrap metal. Others are put into the work although no one is fully confident that a crack would not be produced as the result of the repeated machining of the metal. There is even greater trouble with the "puff pastries"--the low-quality rolled metal which disintegrates when machining into a great number of thin plates. The combine imeni Ilich in the city of Zhdanov, Donetsk Oblast supplies it. However, try reproaching the metallurgists. They have one answer to the justified complaints of the machine builders: if you do not want to take what we give you, then you will get nothing at all."

The Shakhtinskiy Machine Building Plant often does not get all that it needs. Together with scientists of the Donetsk PKTI/Planning and Design Technological Institute/, enterprise specialists have developed, e.g., several special rolled metal shapes which permit a significant improvement in the quality of scraper-loaders and a decrease in their metal content. Five such special shapes were ordered in a timely fashion for the Cherepovets Metallurgical Combine. But they received (greatly delayed at that) a railroad car of the traditional square ones. The useless billets had to be returned, complicating the work with counter of the already overloaded railroad.

Experience has shown that the scraper-loader conveyor most often breaks down. It not only transports the coal removed in the longwall but also assumes the lion's share of the effort of delivering the scraper-loader to the coal facing and cutting work. The main element of the conveyor is the chute--a welded structure made of two shaped sides, a cross bottom, and locked couplers. Because these units wear out quickly, the chute itself also breaks down prematurely.

Now let's imagine this situation: the chute has broken down in the middle of a 200-meter longwall. It is not so simple to deliver a spare part weighing about 300 kilograms to the accident site in the facing where two miners cannot pass. It happens that for one shift you do nothing but eliminate one defect after another. What a benefit of mechanization, the miners say with bitterness, for which a button was pushed--a wet back...

It is a pity and a shame to hear such talk. Even at the start of creating scraper-loaders, we insisted that the chute sides be made without fail from tough 14KhG2S steel. However, for dozens of years the Zhdanov combine Azovstal has been making them from unstable BRK steel which has also been approved by USSR Minchermet. To somehow prolong the short service life of the chutes, they are welding attached pieces made of manganese steel to them at the plant, already metal-intensive machine even heavier.

When manufacturing scraper-loaders, the machine builders more and more often substitute one brand of steel for another. This is understandable under the pressure of circumstances. The USSR Minchermet enterprises are sending them at times out-and-out junk and, at other times, they disrupt shipments of the metal stipulated by the plan; they are indulging in eyewash. After

inserting an eight-millimeter sheet of rolled metal obtained from the Bataysk metal supply and marketing department base into a sheet-bending machine, a worker pushes the pedal of the press. However, instead of bending in half, forming a part of the side of a scraper-loader, the metal breaks with a crunch. The same fate has befallen a second and a third billet. A laboratory analysis has shown that the rolled metal brand does not in fact correspond to that which the metallurgists set for their products. Who are they deceiving? Themselves...

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CSO: 1842/233

FEW CUSTOMERS FOR HIGH QUALITY STEEL

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 5 Aug 86 pp 1-2

[Article by Yu. Antropov]

[Text] We still have much mismanagement at the Oskol Electrometallurgical Combine. The collective is far from being completely formed so the skills of some are inadequate and the discipline leaves much to be desired. However, despite all these troubles the world's best raw material and the most up-to-date technology already today enable us to produce steel, which meets world standards. However, the first-rate metal has not found suitable application: it is used as ordinary metal. Can we really resign ourselves to this? During the 12 years that the first-born of electrometallurgy was being developed no time was found for a proper, state solution of the problem. And, after the 27th CPSU Congress the mismanagement continues. It is as if party requirements do not apply to ferrous metallurgy...

[Signed] B. Kirgizov, steelworker

I read the following parable in a book on the history of science, technology, inventions and discoveries. It seems that a certain genius developed an everlasting sole for shoes. The owner of a shoe company, to whom this marvel was shown after it had been used to walk over all the continents without showing the slightest sign of wear, pompously thanked the inventor; the owner immediately bought the right to the invention and on the spot reduced all the documentation to ashes so that no one could ever use the high-quality product: it threatened to completely ruin the company owner.

This can happen in a world of profits and competition. But, in our planned economy is such an attitude toward innovations really tolerable? We have been talking and writing about the critical shortage of quality steels for decades. We have been making machines, equipment and structures heavier so that we can compensate with mass for the disadvantages of low-quality metal. It seems that the two-century dream of the Russians and the dream of V. I. Lenin about suitable applications for the fabled riches of the KMA [Kursk magnetic anomaly]

is being realized in our days. The miners of the Lebedinsk Mining Concentration Combine extract the raw material, which was given to us by nature and is really the best in the world. The purest concentrate, in which the iron exceeds the projected norm, goes to the Oskol Electrometallurgical Combine. Here, the newest equipment, purchased for high amounts of gold, is in operation as well as the technology of direct iron reduction, which ensures the production of metal with exceptional characteristics; and, this takes place not with individual expert smeltings, but in mass production which today is already counted in hundreds of thousands of tons. Should we ignore this high quality?! [sic]

Boris Vladimirovich Kirgizov is not only a steelmaker. He is also a brigade leader, a metallurgical engineer as well as a member of the combine partkom. Although he is young, he is an erudite man. Is it still possible that Kirgizov is not fully and objectively informed? Or draws the [wrong] conclusions about electrofurnaces not adequately preheated with a turbulent arc?

As he stands next to the furnace at the start of the shift, which again will be very difficult (instead of 5 shifts there are 3 because the brigade does not have a full complement), he has time to say:

"We have already smelted ShKh-15 for bearings. A sheer pleasure! I heard that we are purchasing tubes for the bearing plants with gold. But, we have no orders. How can we comprehend this?"

First, the Combine Chief Engineer V. Simurzin, then Director A. Ugarov, Technical Department Chief V. Martyanov, Central Laboratory Chief A. Yeremetov, and the other workers were unanimous:

"There is no urgent problem."

They became angry as they spoke: there was rage, resentment, disgust and bewilderment in their voices...One knew it was painful. For this reason, the emotions are explainable: they only reflect slightly that which had been seen and read in the documents.

So far, there is no rolling production here. At present, continuously cast steel billets are the final output of the Oskol metallurgists. Generally, there is a fairly large amount of scrap produced from such a "semifinished product" in making rolled products. The reason for this is that the billets are far from ideal. This is true for similar billets, but not for the OEMK [Oskol Electrometallurgical Combine] brand billets. Comparative rolling was staged at the Dneprovskiy Metallurgical Combine imeni F. E. Dzerzhinskiy in January 1986. The steel production of the Dneprovskiy Metallurgical Combine yielded from 1.5-4-fold more technological waste than the Oskol steel.

Some clarifications should be made here. According to the statement of the leading OEMK specialists, literally all continuous cast.

billets of the country's other enterprises require predressing before rolling. Otherwise, the surface defects will become the defects of the entire billet. Such dressing means labor input as well as metal losses. Also, the quality often deteriorates during this operation. The reason one has to resort to this operation is not because continuous casting machines operate poorly everywhere. Simply, the Oskol charge consists mostly of metallized pellets made of practically pure iron; this is what provides the first-rate chemical and physical characteristics of the steel. Secondly, the combine has worked out and uses widely efficient slag-forming mixtures which complete the low-defect technology.

And, how does the Oskol metal behave in machine building?

Before me I have a chart, prepared by the technological department of the combine, on the steel test results for cold heading. GOST 10702-78 requires: no noticeable defects with three-fold heading. The OEMK metal withstood six-fold heading. There were no rejects! The Belebey plant "Avtonormal" conducted the tests. The life service of the high-strength bolts is doubled. The Barnaul plant "Transmash" manufactures a critical part of the diesel engine--the connecting rod--in large quantities using a hot stamping method. Eighty percent of the connecting rods made of steel from the Kuznetsk Metallurgical Combine have defects, which have to be detected and eliminated manually without the hope of complete success. The same connecting rods made of Oskol steel are considerably more reliable: less than one percent of the rods requires additional work. Isn't this impressive?

The Leningrad association "Kirov Plant" is not in need of a recommendation. But, its recommendation of the Oskol metal deserves publication. K. Myasnikov, chief engineer of metallurgical production at this plant, reported: from July to November 1985 40 thousand tons of continuously cast blooms were rolled at this enterprise. The surface quality of the rolled products was high, and the rejects for steel smelting defects were only 0.05 percent.

The finishing touch "to the portrait" is a comparison of the qualities of OEMK metal and the ASTMA29-81 standard specifications of the United States. There is 4.5-fold less sulfur and 3.3-fold less phosphorus in our metal than in the United States standard. The tolerance for billet dressing depth is 28.65 millimeters in their standard, and in ours--a maximum of 8 millimeters.

Seemingly, no commentaries are needed. In principle, OEMK steel should be selling like hotcakes. This steel enables the production of goods with far better features: less weight and more reliable. It appears that relations are being established with Rostselmash, ZIL, the Minsk tractor and pipe plants...There is interest? The steelmaker is wrong?

Let's take in big terms, as the problem deserves.

I have before me an inquiry from the combine technical department--"Inquiry About Delivery of Alloy Steel Brands". Potential customers were asked to examine the feasibility of using, in the second quarter of this year, cast billets of at least 15 brands of steel, from which high strength bolts and bearing tubes, springs and metal cord, and many, many more products can be made. Only from Beloretsk was an order received for four brands, and from Lipetsk an agreement, which was an order for steel "weighing less than one smelting". Refusals came from Kolpino, Dneprodzerzhinsk, Rustavi, Orsk and other places, and in a number of cases there were no responses to the offers.

Only one Onsk-Khalilovo metallurgical combine agreed to a delivery of a very small amount of vacuum steel, although in April 8,203 tons were vacuumed at the OEMK, and in 20 days of May--already 16,400 tons.

Again in May, only the Orsk-Khalilovo combine ordered 400 tons (!) of 35PV steel with a total content of sulfur and phosphorus of less than 0.25 percent.

The PV index certifies the originality of the steel and its best characteristics; as a result of this, strictly speaking, the new production based on the outstanding iron ore resources of KMA was developed. PV means that the charge contains at least two thirds metallized pellets and not more than one third metal scrap, which even with the most thorough sorting contaminates the steel, particularly with additions of nonferrous metals.

The PV index is a guarantee of highest quality. The demand for this metal was only 400 tons, while the monthly output of cast billets was close to 90 thousand tons!

Are the users so dull that they do not understand the enormous real advantages that a metal, produced by a direct reduction method, brings to the national economy? They apparently do understand the advantage, but are afraid to lose. Some are agreeable to take all the metal with a PV index, but at a price on the average of about 117 rubles per ton. That is, at a price of ordinary metal. It is well known that you can't get quality for nothing. By the way, the sharply improved metal cord is one of the factors for significantly increasing the wear of tires compared to present wear. 700kPV steel has enabled this desired advance. However, the price for this advance approximates two hundred rubles for a ton of billets.

There is a category of users of a different type. They do not agree to take PV steel even at the standard price: they are afraid that there will be a directive to pay the real price right after the voluntary use of such a metal. Unfortunately, the already mentioned Kirov Plant Association is among these...

And, this is virtually true for all the brands--practically one hundred percent refusals. The combine's enormous losses stem from this; last year the actual losses exceeded the planned losses by a factor of two and the total losses were over 82 million rubles. An attempt is being made here to reduce production costs, primarily by economizing on resources above the established norms (now, the plan is to save 4.8 million rubles). But, this is a drop in the ocean. The losses are rising steeply.

This expensive absurd situation (the national losses due to using high-quality metal inappropriately, along with restraint of PV index output, are much more significant than the direct losses of OEMK) requires answers to at least three questions. Why did this happen? Who is to blame for what has happened? When will this unheard-of mismanagement end?

Only a naive fellow can assume that all the combine production (oxidized pellets, metallized pellets, electric furnace smelted steel, and rolled products) can become operational at the same time. Even today no one can name the specific time periods that cogging mills were to be introduced, although the plan has specified 1986 as the year. This means that the cast billets are products to be marketed. But, it is useless to look for such production even in this year's supplements to the Gipromez [State All-Union Institute for Planning Metallurgical Plants] plan. More than a million tons of billets have been made and shipped to users from the time the electric furnace steel smelting shop started to operate. These billets do not exist if one believes Gipromez. It is as if they are not a commodity, they are neither this nor that. A general planner is not concerned with the realities, caused in life by his own plan.

Let's take one more document which should serve as a basis for preventing such absurd situations--the technical specifications for "A Continuously Cast Billet of Steel, Smelted With Direct Reduction Iron. An Experimental-Industrial Batch". Why does an experimental-industrial batch consist of millions of tons--even Allah himself cannot answer. However, the important point is something else. These technical specifications, crowned with many reputable signatures and approved as early as 1984 by the Deputy Chief of the USSR Minchermet Technical Administration Yu. Kuznetsov for a period up to 1987, have not been put into effect. And, if this is so, then there are no prices that the Economics Institute of TsNIIchermet [Central Scientific Research Institute of Ferrous Metallurgy] has to calculate. The technical specifications proved to be worthless, and this is why the OEMK has fantastic losses; the high quality of this original metal has, in fact, become a worthless concept. Even the report of the combine's deputy director for economics N. Makashova concerning the fact that the Oskol Combine is not receiving the additional charge of 2.50 [rubles?] per ton, as indicated in the price list, for the fulfilled vacuuming is perceived as an insignificant detail.

On February 7, 1984 the correspondence on "An Experiment in Wasteful Spending" was published in SOTSIALISTICHESKAYA INDUSTRIYA. This correspondence caused a real storm in the leadership of the USSR Ministry of Ferrous Metallurgy at that time. However, the leadership failed to refute the truth, which consisted of the fact that the ministry displayed an inexcusable lack of concern as well as negligence in regard to the application of the new and unique production of the OEMK-metallized pellets. Many thousands of tons were sent to the blast furnaces of the Novolipetsk Metallurgical Combine. Production continued, but there were no orders for shipment. Recently, it was learned that in Cherepovets ordinary cast iron was being smelted from the original raw material.

"And, today we do not have any orders for the shipment of these pellets," said distressed A. Ugarov. "Practically, not a single potential user has the conditions for their storage."

Why have we recalled this sad story about the pellets, which are truly worthless? Not only because the story apparently continues. It repeats itself in a worse form: during the long years of planning, construction and testing of electrometallurgy's first-born the industry staff did not find time to work out the problems, which were vitally important not only for the collective being formed. There is no energetic display of wanting to part with routine or wanting to put an end to a more serious version of wasteful spending, about which steelmaker Kirgizov from Staryy Oskol has expressed his puzzlement.

Stop. Doesn't the weight of former impressions prevail over the present conclusions? Possibly, the industry staff has clear and specific plans with which the managers, OEMK collective and, naturally, the correspondent are not familiar? A talk with "the higher levels" of the ministry should definitely introduce some clarity. It cannot be that the resolutions of the 27th Party Congress and all the spirit of reorganization, carried out in all the country, have not led to a real acceleration in this sector, which by no means is a secondary one.

First Deputy Minister L. Radyukevich, having listened over the phone to the steelworker's letter and the wish to meet expressed by this correspondent, said: "Yes, we have certain work to complete. But, I can't meet with you. I'm busy. Let's postpone our talk. However, I can have the technical administration chief talk to you. He will tell you about our plans. You want to know why such a situation has occurred? I do not want to waste any time on this. I have to think about solutions, to look ahead," said Leonid Vladimirovich didactically as he finished this brief conversation.

The following gathered in the office of the Ministry Technical Policy Chief V. Antipin: Director of TsNIIchermet N. Lyakishev, Director of that institute's engineering center "Efficient Production and Use of Metal Output" A. Brodov, and Chief of the TsNII-

chermet Laboratory of Continuous Steel Casting Yu. Kan. I repeated the crux of the interesting questions and felt that I was beginning to drown in a quagmire of arguments that are as infallible as they are predictable. Steel from the original charge is excellent and has superb properties, such as resistance to cold and cracks. But, the people in Oskol are just learning to walk! They do not produce as yet all the brands set by the plan! Yes, the losses of the enterprise are very great. That is the way it is with beginners. Yes, they are forced to receive a low price. But, what has the ministry to do with this? This is up to Goskomtsen [State Price Commision]!...

The longer the conversation continues, the less I understand. Are they concerned on behalf of the party or the state by the mismanagement that has been permitted primarily by none other than the industry staff? By word of mouth--yes. Measures are being taken: "We are working with the users," "a month ago we established an engineering center for this problem," and "with the rolling mill in operation the Oskol Electrometallurgical Combine will start to make its way..."

It took considerable effort to find out that the people I was talking to cannot give me even any approximate dates for overcoming the mismanagement. This fact and the fact that an examination of the economic state of the Oskol Combine by the ministry board is constantly postponed proves that: the production of a quality metal is one thing, but its efficient use in the national economy is quite another; one should not start a tempest in a teacup; and, that in the past 12 years there was simply no time to solve the discussed problems--these and similar conclusions finally convinced me that steelmaker Kirgizov and his comrades are right.

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EFFECT OF NEUTRON BOMBARDMENT ON LONG-TERM THERMAL FATIGUE STRENGTH OF AUSTENITIC STEELS

Kiev PROBLEMY PROCHNOSTI in Russian No 5, May 86 (manuscript received 10 Oct 83) pp 37-42

[Article by Yu. F. Balandin, A. F. Malygin and V. A. Nikolayev, Leningrad]

[Abstract] Two austenitic steels for nuclear reactors were tested for short-term and long-term strength and plasticity as well as thermal fatigue limit after bombardment with 0.1 MeV fast neutrons in BR-10 and BOR-60 reactors. The 0.8Cr18Ni9 steel had been austenitized at 1050°C or chromonitrided and was bombarded with the neutron fluence varied over the $(0.5\text{-}7.1)\cdot10^{22}$ n/cm^2 or $6.4\text{-}6.7)\cdot10^{22}$ n/cm^2 range at temperatures varied over the 613-873 K or 643-668 K range respectively. The 08Cr16Ni11Mo3 steel had been austenitized at 1050°C or 15% work hardened + stabilized at 800°C for 1 h. This steel was bombarded with the neutron fluence varied over the $(0.37\text{-}9)\cdot10^{22}$ n/cm^2 or $(1.5\text{-}7.1)\cdot10^{22}$ n/cm^2 range at temperatures varied over the 573-923 K or 633-873 K range respectively. Bombardment was done at a rate of approximately $2\cdot10^{18}$ n/(cm$^2\cdot$s). Mechanical tests for tensile strength, percentage elongation, and creep rate were performed on cylindrical specimens 3 mm in diameter. An analysis of the data with the aid of mathematical models have established the effects of radiative hardening, radiative and high-temperature embrittlement, and an annealing of radiative defects. Symmetric thermal cycling was performed on bar specimens 6x0.5 mm^2 in cross-section, in a Coffin machine, with highest cycle temperatures 823 K, 873 K, 923 K, and 1023 K for 1 h at each and lowest cycle temperature 323-723 K. These data have been interpreted in accordance with the equation of thermocyclic elasticity at absolute temperatures lower than half the melting point. A correlation of all results indicates that the thermal fatigue limit is first lowered in short cycling by radiative embrittlement and then raised in long cycling by radiative hardening. A comparison with the behavior of these steels before neutron bombardment reveals that the differences narrow down with higher fatigue-test temperature, which is attributable to phase transformations as well as to annealing of radiative defects. The dependence of the thermal fatigue limit on the neutron bombardment dose establishes, together with the mechanical criterion for short-cycle fracture, estimates of long-term thermal fatigue resistance in a radiation environment. References 20: 13 Russian, 7 Western.

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CREEP CHARACTERISTICS OF 03Kh20N45MBCh ALLOY AFTER BOMBARDMENT BY IONS DEPENDING ON DEGREE OF GAS ABSORPTION

Kiev PROBLEMY PROCHNOSTI in Russian No 5, May 86 (manuscript received 17 Sep 84) pp 43-45

[Article by V. N. Kiselevskiy, V. V. Kovalev, V. G. Kovyrshin and V. S. Krasilnikov, Strength Problems Institute, Nuclear Research Institute and Metal Physics Institute, UkSSR Academy of Sciences, Kiev]

[Abstract] In an experimental study of the 03Kh20N45MBCh alloy, it was bombarded simultaneously with helium and hydrogen ions from a glow-discharge plasma, in doses of $3\cdot10^{22}$-$2\cdot10^{23}$-$2\cdot10^{24}$ ions/m^2 at 100°C, for the purpose of determining the dependence of its heat resistance on the amount of absorbed gases. A microstructural examination under a scanning electron microscope revealed a fine-grain phase and disperse carbide inclusions in sizes ranging widely from tens to hundreds to microns, their concentration at the surface increasing upon bombardment by ions of both gases. It also revealed partial erosion of the alloy surface by flaking, but no blistering. The atomic helium content in the alloy, measured by the method of thermodesorption kinetics over a temperature range up to 1000°C, did not exceed 10^{-6} atom.%. Two principal stages of thermodesorption have been established within the 270-700°C range, with peaks at 400°C and 600°C respectively, several peaks within the 700-1000°C range being attributable to processes which control evolution of helium in the crystal lattice or its interaction with structural defects. Sufficient helium was found to remain in the alloy at 650°C to influence its mechanical properties at that temperature after plasma treatment. Specimens were tested for creep and long-term strength in the materials research channel of the VVR-M water-moderated water-cooled reactor at the Institute of Nuclear Research (UkSSR Academy of Sciences), in a stream of 1 MeV or higher-energy thermal neutrons of $4.2\cdot10^{17}$ or $4.7\cdot10^{17}$ n/($(m^2\cdot s)$) intensity. The results indicate stabilization of the creep rate at a stress level which increases with increasing dose of ion bombardment. A comparison of creep curves corresponding to equal stress levels but different levels reveals that the third stage of creep becomes shorter, causing a decrease of plasticity, as the amount of absorbed gas increases with an attendant decreasing contribution of the alloy matrix to the total strain. References 3: all Russian.

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CSO: 1842/234

UDC 621.791.92:669.14.018.258.2

PLAIN CHROMIUM STEEL WITH BORON FOR FACING PUNCHES USED IN COLD FORMING

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 7, Jul 86 pp 50-51

[Article by V. M. Karpenko, B. A. Brusilovskiy and I. I. Gunko, Kramatorsk Industrial Institute]

[Abstract] A study of a new tool facing steel with boron (0.7-0.9% C, 0.7-0.9% B, 4.5-4.9% Cr, 3.0-3.5% Mn, 1.5-2.0% Si, $\leq$ 0.01% Ta) for cold forming was made, including microstructural examination under an MIM-8 optical microscope as well as REM-200 and UEMV-100K electron microscopes. Punches for cold forming at the Druzhkovka Metalware Manufacturing Plant were faced with this steel in a welding pool. Phase analysis in a DRON-0.5 x-ray diffractometer revealed two eutectic systems, Fe-Fe_2B and Fe-Fe_3C, as well as a peritectic interaction $L+ Fe_2B \rightarrow Fe_3C$, along with borides Fe_3B and FeB, carboborides $Fe_2(B,C)$ and Fe(B,C), cementite $(Fe,Mn)_3C$, borocementite $(Fe,Mn)_3(B,C)$, intermetallic compound FeCr, and Fe_5Si, $Fe_3(Si,B)_3$. The properties of this steel can be controlled by heat treatment, its toughness being increased by quenching from a temperature (900°C) at which carboboride $Fe_3(B,C)$ dissolves in the austenite and its strength being increased by subsequent tempering at a high temperature (500°C) at which intermetallic compound FeCr precipitates during dispersion hardening. The results of mechanical tests indicate that this boron steel has not only a higher impact strength but also a higher wear resistance than molybdenum steel Cr12Mo and even tungsten steel 8Cr3MnSiW2V. References 6: all Russian.

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CSO: 1842/247

USE OF ARMENIAN COPPER POWDER BY LOCAL ENTERPRISES URGED

Yerevan KOMMUNIST in Russian 27 Jul 86 p 2

[Article by G. Mosinyan, economist, N. Mesropyan, KOMMUNIST staff correspondent: "Copper Powder: Who Needs It?: Managing Conscientiously"]

[Text] In recent decades, powder metallurgy has evolved as one of the most important sectors in the production of sintered metal articles. The achievements of powder metallurgy have been the result of development of new, high-efficiency processes for powder production and subsequent processing. Their low cost and high quality are the key indicators which determine use of powders in the national economy. We might note also that when various parts are manufactured using powder metallurgy, the metal utilization factor increases to 0.95. This is the truest path to no-waste technology.

Initiative and Business Acumen

As they say, these are two qualities you cannot deny N. Sarkisyan, director of the Alaverdi Mining and Smelting Combine. Thanks to him, the combine has undergone major transformations in recent years.

Several years ago, upon hearing the director's inspiring stories about copper powders and about the many areas where they can be used, most listeners (including the author of this article) thought that it was all a program for the distant future. The higher-level organizations were of the same opinion. "Well," they said, "It's a worthwhile matter, but it should once again be considered, analyzed, coordinated, settled, and approved...."

And then the director decided to build a shop--with his own resources. Wasn't it risky? Yes, and what a risk! Insiders, as well as outsiders, had their doubts. But, meanwhile, the director got the construction materials and equipment and stood for hours at the test unit that produced the first kilograms of powder.

At first glance, it seemed that there was nothing complicated about producing the powder. Crush the molten copper with powerful air and water currents, and the powder is ready. However, the first commercial tests posed many problems. After testing a lot of brass powder, specialists at the Elektrokontakt plant in Kineshma noted that it satisfied requirements for bulk density

and yield, but did not meet approved specifications for oxygen content, partial-size distribution and strength. They labored over these deficiencies for four months. A new test revealed a new deficiency: during extrusion, it was noticed that the copper "blew out" of the dies. So again, work and dozens of tests.

The nature of the results of this work is clearly evidenced by the fact that, in the beginning of this year Elektrokontakt stopped using the services of other suppliers and now receives the entire amount of brass powder it requires from Alaverdi. This is primarily because Alaverdi powder is distinguished by high quality and good tendency to cake, and--most important--it costs much less than similar powders. At Kineshma itself, for example, they calculated that switching manufacture of just one part to powder methods saves about 100,000 rubles per year. The plant now makes more than 10 such parts. The benefit is obvious.

The first tons of powder were obtained just recently at Alaverdi--in 1979. Since then, the technology for producing powder from copper and its alloys, developed jointly by the Ukrainian SSR Academy of Sciences Institute for Materials Science Problems and the Armnitsvetmet Institute and the combine, has received universal recognition.

Do we need to produce copper powder? They think so at the combine and elsewhere. Tractor builders, automobile builders, electrical engineers, instrument makers--in a word, almost all the leading sectors of industry--acutely need copper and copper-alloy powder. The combine maintains close contacts with many industrial enterprises and is developing long-range plans.

They are giving priority to plans for on-site manufacture of parts from copper and copper-alloy powder. Precisely so, at the combine they quite rightly believe that there is no advantage in being just a supplier of raw material. It is much more effective to sign contracts with industrial enterprises to supply finished parts.

A good deal has been done to implement this program. A new production building has already been erected and presses have been installed. Installation of roasting furnaces will soon begin. Preparation for production of the first parts is proceeding. For example, compensators and parts for gear pumps for the famous Don combine will be manufactured here. Now they are produced by machining at one of the Vinnitsa plants. As calculations show, the Alaverdi parts will cost much less, and their service life will nearly double. In addition, study on the basis of a development project by Armpromtsvetmet, brake shoes for the Zhiguli will also be produced here, and there will no longer be a scarcity of this undercarriage spare part.

There are many plans, and--we can now state categorically--they will be accomplished. But here's the surprising thing. After familiarizing ourselves with the list of current and potential users of Alaverdi copper powder and parts made of it, we did not find one buyer from our republic.

Why?

The people at the combine answer this question directly and honestly, "We don't know."

And then they add, "We are powder producers. According to all the rules, users should come to us, not we to them. And they are coming--from Kiev, Minsk, Rostov, Kineshma...."

All these cities are rather far from Alaverdi. But Kirovakan is nearby--just an hour's travel by bus. And there are enough enterprises more or less related to metal-working here. So why does news about the inexpensive, high-efficiency Alaverdi powder reach, let's say, Kineshma faster than neighboring Kirovakan? To explain this paradox, we turned to certain industrial enterprises in the city.

"We use nonferrous metals very little and, therefore, feel that the gain is not worth the pain," V. Shakhbazyan, chief production engineer at the precision machine-tool plant told us.

We heard approximately the same answer at the lighting engineering plant which uses 130 tons of nonferrous metals a year, 35 of which, by the way, end up as wastes.

The largest user of nonferrous metals in Kirovakan is the Avtogenmash Plant. It consumes 2,800 tons of brass and 600 tons of copper a year, and 40 percent of the total amount ends up as chips. Under these circumstances, switching the majority of autogenous welder parts to manufacture from powder offers major benefits. As E. Bodzhikyan, plant director, told us, they will not receive the first parts manufactured at Alaverdi until 1987, and then only in a niggardly amount--just 5 tons. You cannot accomplish a major renovation at those rates. We did not find other republic enterprises even attempting to set up any relations with the Alaverdi Combine.

No comments needed, as they say. The search for new, advanced technologies is an integral part of the concept of "acceleration." For those enterprises which indeed need to accelerate to take the first steps toward no-waste production, Alaverdi copper powder can perform a valuable service.

12809/12947
CSO: 1842/251

UDC 541.44 : 546.3

REACTIONS OF MAGNESIUM-PRASEODYMIUM AND MAGNESIUM-NEODYMIUM ALLOYS WITH HYDROGEN

Baku AZERBAYDZHANSKIY KHIMICHESKIY ZHURNAL in Russian No 5, Sep-Oct 85 pp 108-110

[Article by K. N. Semenenko, V. N. Verbetskiy, V. Ch. Alyyev, A. Gasanzade, and T. Kh. Kurbanov, Azerbaydzhan SSR Academy of Science Inorganic and Physical Chemistry Institute]

[Abstract] Reactions of hydrogen with Mg-Pr and Mg-Nd alloys containing sufficient amounts of Mg to produce pure $Mg_{12}Pr$ or $Mg_{12}Nd$ intermetallics or intermetallic and Mg phases were studied by a previously described method and compared with previously reported studies of hydrogenation of Mg-Ce and Mg-La intermetallics. It was found that, unlike in the case of Mg-Ce and Mg-La intermetallics, the hydrogenation products always contain the Mg phase in addition to MgH_2 and PrH_3 or NdH_3 hydrides. The hydrogenation rate of Mg-Pr and Mg-Nd alloys is lower than that of $Mg_{12}Ce$, Mg-Pr alloys showing the lowest rate. The decreasing reactivity in the series CeH_3-MgH_2, LaH_3-MgH_2, NdH_3-MgH_2, PrH_3-MgH_2 is attributed to the increasing stability of hydrides in the series CeH_3, LaH_3, NdH_3, PrH_3 and the resulting hydrogen concentration increase [as given--probably should be "decrease"] over the hydride phase in this series, atomic hydrogen being produced by the decomposition of rare-earth trihydrides to hydrogen and dihydrides. References 7: 2 Russian, 1 Hungarian, 4 Western.

12973/12947
CSO: 1842/201

UDC 541.12.034.2:669.083.2

EFFECT OF HIGH PRESSURE ON ELECTRICAL RESISTANCE OF PbSe-GeSe ALLOYS

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 22, No 6, Jun 86 (manuscript received 11 Sep 84) pp 903-905

[Article by V.F. Skums, L. V. Prokofyeva, B. L. Valevskiy, A. S. Skoropanov, A.A. Vecher, R. L. Pink and Yu. S. Maslenko, Belorussian State University imeni V. I. Lenin and Scientific Research Institute of Physical Chemistry Problems]

[Abstract] A study of PbSe-GeSe alloys under high pressure at room temperature was made, considering that normally PbSe has a cubic crystal lattice of the NaCl type and GeSe has a rhombic crystal lattice. Beginning at a pressure of 4-4.3 GPa, at room temperature, the cubic crystal lattice of PbSe transforms into a rhombic one of the SnS type. Meanwhile, the solubility of GeSe in PbSe remains below 10 wt.% even at 520°C. Specimens of spectrally pure PbSe and of its alloys with 0.02, 0.5, 1, 2, 5, 7.5, 15 wt.% GeSe also spectrally pure were prepared for measurement of the electrical resistance R with the pressure P varied from initial 1.4 GPa to final 8 GPa. Data on 10-12 specimens of each material, based on pressure readings with an error not larger than 4-6% and electrical resistance readings with an error not larger than 1-2%, have been processed in the $\log(R_i/R_f) = f(P)$ form. The results reveal an upward jump of electrical resistance within the phase transformation range, with neither the width of this pressure range nor the pressures at which it respectively begins and ends depending on the GeSe content. The magnitude of the electrical resistance throughout the entire pressure range as well as the magnitude of its jump, however, are found to depend on the GeSe content: both increase fast to a maximum as the GeSe content is increased up to 2 wt.% and then decrease slowly as the GeSe content is increased further. References 7: all Russian.

2415/12947
CSO: 1842/237

UDC 669.24'295:620.181

SHAPE 'MEMORY' EFFECT AND MARTENSITE TRANSFORMATION IN ALLOYED TiNi

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 7, Jul 86 pp 22-25

[Article by N. N. Bashanova, N. F. Zhebineva, S. G. Fedotov and D. B. Chernov, Metallurgy Institute imeni A. A. Baykov]

[Abstract] A study of stoichiometric TiNi was made for the purpose of determining the effect of 1-8% V, 1-10% Nb, 1-5% Ta, 1-4% Cr, 1-2% Fe, 1-3% Co not only on the temperatures at which martensite and austenite transformations

begin and end but also on the temperatures at which thermomechanical shape distortion during martensite transformation under a flexural load begins and ends as well as the temperatures at which shape recovery after hot deformation to 30-40% reduction at 900°C begins and ends. All alloys were smelted in suspension with high-purity ingredients, cast cylindrical specimens 5-8 mm in diameter then being rolled with shells of St3 steel into strips for analysis and testing. The critical transformation temperatures were determined on the basis of differential thermal analysis. The temperatures of thermomechanical shape hysteresis and "memory" were determined during heating-cooling cycles under a flexural load. The results indicate that alloying TiNi with Cr, Fe, Co lowers these temperatures appreciably, while alloying it with V, Nb lowers them slightly and alloying it with Ta raises them slightly. Alloying with any amount of Nb produces a positive hysteresis of austenite-martensite transformation temperatures. The effect of hot plastic deformation on the transformation temperatures depends on the alloying element and its amount, generally lowering the M_s point of TiNi with lower alloy content and raising the M_s point of TiNi with higher alloy content, also raising the A_s point of TiNi-Nb and TiNi-Fe alloys. References 3: all Russian.

2415/12947
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UDC 620.17:669.295

DEPENDENCE OF PROPERTIES OF VT3-1 TITANIUM ALLOY ON PARAMETERS OF ITS LAMELLAR STRUCTURE

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 7, Jul 86 pp 52-55

[Article by M. Ya. Brun, G. V. Shakhanova and I. V. Soldatenko]

[Abstract] A study of the VT3-1 titanium-tungsten alloy was made for the purpose of determining the dependence of its mechanical properties on parameters of its lamellar structure. Two batches of rolled cylindrical specimens, 18 mm and 25 mm respectively, were annealed at a temperature 100°C above the $(\alpha + \beta) \rightarrow \beta$ phase transformation temperature and then cooled in water or in a furnace. The dimensions of structural components in these specimens were regulated by varying the subsequent 2-step heat treatment: first step at 850-900°C for 1-50 h + cooling at a rate of 1 K/s or 10 K/s; second step at 700-900°C for h + furnace cooling. The structural parameters thus varied were the size of β-phase grains, the size of α -phase clusters, the thickness of lamellas of primary α -phase, and volume fraction of secondary α -phase. The results of mechanical tests indicate that tensile strength, ultimate strength, and fatigue limit increase with a decrease of any structural dimension, especially the thickness of α -phase lamellas, and with increasing volume fraction of secondary α -phase, while plasticity (percentage elongation and percentage reduction) as well as toughness and creep limit increase with increasing size of α -phase clusters and of α_I-phase particles but with

decreasing volume fraction and dispersion of lamellar α_{II}-phase precipitate. Enlargement of β-phase grains results in higher surface density of crack propagation energy and higher toughness but lower surface density of crack initiation energy and lower percentage reduction. The sensitivity of mechanical properties to structural changes decreases with increasing size of the α-phase clusters and lamellas. References 6: all Russian.

2415/12947
CSO: 1842/247

UDC 620.18.620.17:669.295

DEPENDENCE OF RESISTANCE OF DEFORMED TITANIUM ALLOYS TO SMALL PLASTIC DEFORMATION ON ANNEALING TEMPERATURE

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 7, Jul 86 pp 55-57

[Article by D. A. Prokoshkin, T. A. Panayoti, A. S. Gorbova and G. F. Taran]

[Abstract] A study of three high-strength titanium-tungsten alloys (VT3-1, VT9, VT22) was made for determining the dependence of their electrical resistivity, Young's modulus, microhardness, and especially resistance to small plastic deformation on the annealing temperature. Ribbon specimens 100 mm long and 5 mm wide for mechanical tests and electrical resistance measurements were cut from 0.4 mm thick tape of each alloy produced by hot rolling of cylinders 25 mm in diameter at 800°C. These specimens were annealed at temperatures of 400°C, 500°C, 600°C, 700°C, 800°C in a vacuum furnace under a residual pressure of $(1.33\text{-}13.3)\cdot 10^{-3}$ Pa. Microhardness was measured with a PMT-3 tester using a 0.5 N load, microstructural examination was done under an electron microscope and under an optical one. The electrical resistivity of all three alloys, initially 19.5-20.5 μohm·m, was found to decrease after annealing at any temperature within the 400-800°C range. Microhardness and Young's modulus of all three alloys were found to become maximum after annealing at 500°C, this effect being most appreciable in the case of the VT3-1 alloy. These trends are attributable to structural changes and aging. Resistance to small plastic deformation was evaluated on the basis of changes in the elastic limit, with a small allowance $\sigma_{0.002}$ for residual strain. This resistance of all three alloys was found to increase after annealing at 500°C, recrystallization during annealing at higher temperatures causing grain growth and disorientation with attendant softening. Most resistant was again found to be the VT3-1 alloy, with a higher C,N_2,O_2 content than the other two. References 4: all Russian.

2415/12947
CSO: 1842/247

UDC 669.715.48:621.74

OPTIMIZATION OF ALUMINUM SCRAP MELTING

Moscow TSVETNYYE METALLY in Russian No 7, Jul 86 pp 76-79

[Article by Yu. V. Andreyev]

[Abstract] Standard equipment for reprocessing aluminum scrap as secondary source of aluminum alloys now includes a bipartite reverberatory furnace with a maneuverable charger which also stirs the melt, fluxes it, and skims it. While now secondary aluminum alloys are produd 80% by this method, remelting in an electric furnace yields 20% of the total production volume. The main requirement for processability of scrap metal with a large developed surface and high degree of contamination is its meltability in a melt. This minimizes loss of metal by oxidation and accelerates the remelting process. The advantage of reverberatory smelting is its versatility, especially where lower-grade scrap metal is involved, which makes this process virtually a universal one. The advantage of electric smelting is a much more uniform heat and mass transfer, production by this method having increased tenfold since the mid-1960s. Reverberatory smelting can be improved in this respect by proper preparation of the scrap, but overall optimization of the scrap remelting process requires radically new concepts. A rotating-drum furnace ensures good contact between aluminum melt and liquid flux so that refining reactions can proceed till the metal is completely purged of gaseous and nonmetallic includions. Uniform rotation will, moreover, prevent overheating of the flux. Overhaul or replacement of existing reverberatory furances in the major nonferrous scrap processing plants (Kharkov, Podolsk, Moscow) should be carefully weighed on the basis of experience, engineering design, and economic feasibility. References 5: 4 Russian, 1 East German.

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UDC 669.715.48

FEASIBIILTY OF REPLACING PRIMARY ALUMINUM ALLOY WITH SECONDARY ALUMINUM ALLOY FOR AUTOMOBILE ENGINE CASTINGS

Moscow TSVETNYYE METALLY in Russian No 7, Jul 86 pp 82-84

[Article by A. S. Kaufman, Zh. V. Tokareva and L. I. Zhutov]

[Abstract] Mechanical properties of the oxide film forming on the free surface of an aluminum melt and shielding the latter against the inflow or gases, dependent largely on the rheological characteristics of the physical system, were measured with a tungsten indenter 1 mm in diameter carrying a set of strain gages for recording the film deformation until rupture on an oscillograph. The corundum crucible with aluminum melt had been placed inside an electric resistance furnace, its temperature being measured with a Chromel-

Alumel thermocouple and recorded with a KSP-4 potentiometer. The temperature was regulated by means of a control transformer and maintained within the 720-750°C range. Oxide film was allowed to build up for over 60 min before each test. The experiment was performed with AL32 alloy, then with the same alloy containing additives and with Ak9M secondary alloy. The oxide film was in each case found to behave as an elastoplastic body, first deforming elastically and then flowing plastically until rupture, a thin indenter having been used so as to produce a high-stress site. The results indicate that most elastic is the oxide film on AL32 alloy melt with 0.18% Zr or 0.3% Ce, each of these added elements contributing to formation of a continuous and stable oxide film. Addition of 0.4% Zn to the AL32 alloy was found to result in a somewhat weaker and less elastic oxide film. Meanwhile, properties of the oxide film on AK9M alloy melt containing Zn and Ni were found not be influenced by these two impurities, its lower strength and elasticity being compensated by faster recovery after rupture. It therefore appears to be feasible to replace the AL32 primary aluminum alloy with the AK9M secondary one for automobile engine castings, provided that the latter alloy does not contain more than 0.4% Zn. The hermeticity of such castings was checked on experimental 7000 pieces at the Ufa Autombile Manufacturing Plant, tests by the Gudchenko method indicating a lower gas content than in castings of AL32 alloy but the 8.5 lower reject rate being partly offset by a larger loss of material in skimming of the melt. References 6: 4 Russian, 2 Western (both in Russian translation).

2415/12947
CSO: 1842/246

PRODUCING DIAMONDS FROM GAS

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 21 Jun 86 p 1

/Article by V. Lagovskiy: "Diamond Rain"/

/Text/ "The week is over, what are you happy with?"

"With the diamonds," Professor D. Fedoseyev, head of the laboratory of the Institute of Physical Chemistry of the USSR Academy of Sciences, answered simply. "Look..."

The dark crystal particles iridesced with a steel brilliance, but they were so small that I had to examine them through a microscope.

"One can now synthesize on a larger scale," I said disappointedly.

"Still," the head of the department, corresponding member of the USSR Academy of Sciences B. Deryagin, joined the conversation, "graphite must be incandesced and compressed under enormous force for this. But we 'mine' diamonds from gas which is only slightly heated and under normal pressure."

Who would believe such a thing until recently--obtaining the hardest material on earth from a gaseous substance. However, scientists would be even more surprised if you told them that this process has existed for dozens of years and industry obtains tons of diamonds, it is true, without knowing anything about such a treasure.

"Do you wonder where it was hidden?"--D. Fedoseyev smiles. "In motor vehicle tires--there are several carats of precious crystals in each one. We found out about this through research we are conducting jointly with the Institute of Material Technology Problems of the Ukrainian Academy of Sciences."

"Where do the diamonds in rubber come from?"

"From the soot that goes into the tires," the scientist explained.

Soot, as is generally known, is obtained in plasmotrons, by burning hydrocarbons. The process is simple and was developed a long time ago and, apparently, therefore the desire to thoroughly research it did not occur to anyone. But it interested our heroes, for soot is the same carbon. Why is just it

obtained, and not a diamond? The answer to this question was so unexpected that the scientists dared to claim an invention. It turned out that soot is formed only at the very end of the operation, but at the beginning diamonds rush out of the most ordinary plasmotron! However, they burn out before seeing the light. It is true, as it was later explained, that not all of them do this--some still settle on the cold walls and get into the tires along with the soot. This also suggested an idea to the scientists on how to secure an amazing conversion. The gas must be suddenly cooled and then scattered as diamond rain.

"By the way," B. Deryagin says,"our own experiments have corroborated the old hypothesis. By studying anomalous light dispersion, astrophysicists have conjectured that there are diamonds in interstellar dust. However, there is no explanation for how they got there. Now it can be boldly said: diamond dust has been condensed in space from hydrocarbon vapor. Radioastronomers discovered it a long time ago."

However, let us return to earth from the stars. Industry needs diamond dusts very much. Emery disks can be manufactured from them and they can be baked into large polycrystals. Scientists showed me two such samples. One on a cushion, cut for beauty--was exactly the same as a "black diamond." The other was inserted in a cutting tool. Such a tool can work many times longer and faster than the usual ones.

This is the work literally of recent days--metallic plate coated with a diamond layer. I tried to scratch it with a tack but nothing happened.

"The layer consists of the smallest diamonds which can only exist in nature--there are a total of ten atoms of carbon in each one," explains B. Deryagin. "Scientists from the Institute of Petrochemical Synthesis of the USSR Academy of Sciences helped us to obtain it from a common medicine--remantodin. I think that such a layer can serve not only as a sturdy coating but will also become useful in medicine."

The scientists are continuing the research, there is much more for them to aim at. It is not yet clear how diamonds originate in nature. Who knows, maybe through such non-traditional methods of synthesis, some time a laboratory will succeed in reproducing the processes in which the world-famous Kulinan and Shakh stones are born.

8524 /12947
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UDC 681.3:621.316

CONTROLLING TEMPERATURE OF REACTION CELL IN HIGH-PRESSURE APPARATUS DURING SYNTHESIS OF SUPERHARD MATERIALS

Kiev SVERKHTVERDYYE MATERIALY in Russian No 2, Mar-Apr 86 (manuscript received 12 Mar 85) pp 7-10

[Article by R. L. Pink, Superhard Materials Institute, UkSSR Academy of Sciences, Kiev]

[Abstract] Temperature control in high-pressure apparatus for synthesis of superhard materials is analyzed, the reaction cell being usually heated in an electric furnace. Regulation of the electric power is examined precisely by taking into account changes in the electrical resistance of the reaction cell during the process and the resulting redistribution of heating power among the current-carrying heater conductors. While current control is more efficient, voltage control is more precise. The maximum attainable precision is shown to depend on the ratio of cell resistance to heater resistance. In the case of current control it will be only within 1-1.5% as that ratio approaches 20. Making this ratio still larger is not technically practical, being as difficult as inserting a thermocouple into the reaction cell. In the case of voltage control, a precision within 0.07-0.5% is attainable with a resistance ratio of 1. These conclusions have been verified experimentally. In a real situation both voltage and current vary within 3.5% so that the power will stabilize not better than within approximately 5%. The experiment was performed by M. V. Sidorchuk from the Institute of Cybernetics, UkSSR Academy of Sciences. References 4: all Russian.

2415/12947
CSO: 1842/235

UDC 66-987:621.3:661.65

STRUCTURE OF TWO-LAYER COMPOSITE MATERIAL PRODUCED BY SINTERING CUBIC BORON NITRIDE WITH HARD ALLOY

Kiev SVERKHTVERDYYE MATERIALY in Russian No 2, Mar-Apr 86 (manuscript received 6 Mar 86) pp 10-12

[Article by A. A. Shulzhenko, A. I. Ignatusha, S. A. Bozhko and A. N. Vashchenko, Superhard Materials Institute, UkSSR Academy of Sciences, Kiev]

[Abstract] A study of the two-layer composite material consisting of polycrystalline cubic BN and VK6 tungsten-cobalt alloy as substrate was made, such a material for cutting tools being produced by sintering under high static pressure at temperature above the Co-BN liquidus. Its structure was examined under a Camscan electron microscope with a Link 860 attachment for local quantitative chemical analysis. In the 900 μm thick BN layer only a 100 μm thick zone adjacent to the substrate contained W and Co, naturally maximum at the boundary with 3 wt.% W and 6 wt.% Co, evidently forming borides Co_2B or $W_2Co_{21}B_6$. Deeper into the substrate the Co content first dipped to 4.5 wt.% at a depth 100 μm below the boundary and then rose gradually to 7 wt.% at the back surface, while the W content correspondingly peaked to 95.5 wt.% and then gradually dropped to 93 wt.% at the back surface. The hardness of the polycrystalline BN cutting layer, measured with a Knoop tester, was close to 32 GPa. References 4: 3 Russian, 1 Western.

2415/12947
CSO: 1842/235

UDC 621.95.025.7:666.233:668.9

DIAMOND DRILLING OF HIGH-STRENGTH GLASS-PLASTICS AND BORON-PLASTICS

Kiev SVERTHTVERDYYE MATERIALY in Russian No 2, Mar-Apr 86 (manuscript received 12 Feb 85) pp 54-58

[Article by V. P. Karpov and A. A. Stepanov, Leningrad Mechanics Institute, Leningrad]

[Abstract] A study concerning the use of diamond drills for high-strength glass-reinforced and boron-reinforced plastics was made at the Leningrad Mechanics Institute, its main purpose being to establish the dependence of precision, productivity, and surface finish on the technological process parameters. Experiments were performed with special laboratory equipment, which included an internal-grinding spindle and an electrically driven spindle rotating at speeds of 18,000 rpm and 36,000 rpm respectively. Aqueous soda solution served as coolant. The drills varied in diameter from 5 to 50 mm

and in length from 40 to 100 mm. Face drills had been produced on a Ni binder by electroplating, counterboring drills had been produced some by the same method and some on a Cu-Sn binder by powder metallurgy. Two grades of diamond were used: coarse AS6 with 50/40 grain count and fine AS15 with 400/315 grain count. The experimental data have been evaluated with the aid of the monolayer model for cylindrical friction and wear surfaces. Fine-grain diamond was found to have a much higher wear resistance than coarse-grain diamond, against either glass-plastic or boron-plastic material, wear of the binder having no appreciable effect on the drill life in terms of dimensional precision of holes. Both the axial force and the resisting moment depend largely on the drill diameter and on the axial feed rate, negligibly on the cutting speed and on the diamond grade or grain size. The roughness of a glass-plastic or boron-plastic surface in a hole depends mainly on the diamond grain size, somewhat on the axial feed rate, and hardly at all on the cutting speed. The productivity of the drilling process is determined by the axial feed rate and, with the same diamond grain size, can be increased only by an increase of the drill speed and only up to a limit set by the available power capacity of the equipment. It can also be increased by use of larger diamond grains, moreover, but the limiting factor here is the drill size. The productivity of diamond drills under optimum operating conditions is 1.5-4.5 times higher than that of standard twist drills. Electroplated diamond drills are preferable to sintered ones, because they attain a higher productivity with a smaller cutting force. Because of the many parameters involved, drill design and performance standards have been set up separately for each diamond grade and for each material based on constant drill speed of 8500 rpm and maintenance of Class 12 dimensional hole precision correction factors for drill life at other speeds (5,000-12,000) regardless of drill diamter when drilling boron-plastic and for drill life in other precision classes (13-14) depending on drill diameter when drilling boron-plastic or glass-plastic. References 5: all Russian.

2415/12947
CSO: 1842/235

UDC 621.923.02:621.921.34:666.233

MACHINING SPRAY-COATED CORES FOR MAGNETIC HEADS

Kiev SVERKHTVERDYYE MATERIALY in Russian No 2, Mar-Apr 86 (manuscript received 10 Oct 84) pp 59-61

[Article by G. P. Kremnev and Ye. G. Krzhechkovskiy, Odessa Polytechnic Institute, Odessa, and A. I. Yefremov (deceased), Donetsk]

[Abstract] Flat grinding and lapping of Permalloy cores after their coating by the vacuum deposition process was studied, these machining operations being necessary for ensuring adequate surface smoothness (R_z= 0.1-0.2 μm) and dimensional surface precision (nonplanarity not exceeding 0.5 μm over entire core length). Rough grinding was done with ASM 14/10—Br-100 diamond wheels in a model 3701 machine tool: circumferential wheel velocity 20 m/s,

longitudinal feed rate 0.1 m/s, depth of cut 0.003 mm, transverse table shift 0.5 mm/pass. This operation reduced surface roughness and nonplanarity to 0.35 μm and 1 um respectively. Subsequent finish grinding was done by oscillatory rather than circular movement of the lap in a model PDS-3M machine tool. For this operation there was used 20% paste of 24A white electrocorundum + 63S green carborundum in 30% oleic acid + 10% castor oil + 40% stearin, also with TiC or synthetic diamond instead of electrocorundum. This operation reduced roughness and nonplanarity to within specifications. Performance evaluation and optimization of the lapping process was done by means of a planned experiment on a 12x12 mm^2 frame with a 10% speed differential between the connecting rods making 180 double strokes per minute for a cutting speed of 0.11 m/s under a constant pressure. Pressure and lapping time were the variable parameters, the pressure varied over the 10-50 N/cm^2 range and the time varied from 30 s to 180 s. Paste containing synthetic diamond was found to withstand higher pressures than the other abrasives and its performance thus to be controllable over a wider range. The best surface finish was obtained by lapping with synthetic diamond + 63S green carborundum paste for a period of 180 s under a low pressure of 10 N/cm^2, the cutting speed being 0.11 m/s, but maximum productivity with this paste was achieved by lapping under a high pressure of 50 N/cm^2.

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UDC 666.76.01+621.48

EFFECT OF OXIDATION ON STRENGTH OF REACTION-SINTERED Si_3N_4 CERAMIC

Kiev POROSHKOVAYA METALLURGIYA in Russian No 5, May 86 (manuscript received 10 Apr 85) pp 40-44

[Article by Yu. G. Gogotsi, A.A. Gogotsi and O. D. Shcherbina, Kiev Polytechnic Institute]

[Abstract] A study of reaction-sintered 70:30 Si_3N_4-SiC NKKKM structural ceramic containing 2% mGO activator was made for the purpose of determining the effect of oxidizing heat treatment at 1400°C on its mechanical strength at 1400°C and at 20°C. The material was produced from KPS-3 silicon powder containing 0.01-0.1% A1,Ti,Mn,Ni,Cu impurity and 0.6% grinding Fe dust. Some specimens cut from 55 mm long square bars 5.5x5.5 mm^2 in cross-section were oxidized and some were not. The oxidation rate at 1400°C decreased and after 1 h stabilized with formation of an approximately 10 μm thick oxide surface film. Phase analysis in a DRON-2.0 x-ray diffractometer with a CuK_α-radiation source revealed in it α -cristobalite and a glassy phase as well as silicates (diopside, forsterite, augite, enstatite). Mechanical tests were performed by the method of 3-point flexure on an MIK-9 machine, calculation of the strength being based on the standard formula disregarding nonlinearity of the stress-strain curve. Oxidation was found to decrease the strength at 1400°C appreciably, the main cause being etching of grain boundaries with formation

of liquid phase. The strength at 20°C, after removal of the oxide surface film by machining, was found to be somewhat higher than without oxidation. This is attributable to curing and purifying of a defective ceramic substrate by the oxide film. References 13: 8 Russian, 5 Western.

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UDC 546.657.241:548.55

GROWTH AND PROPERTIES OF $CdInSbS_4$ SINGLE CRYSTALS

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 22, No 5, May 86 (manuscript received 27 Jul 84) pp 726-728

[Article by T. Kh. Azizov, G. G. Guseynov, A. S. Kuliyev and R. A. Nagiyev, Physics Institute, AzSSR Academy of Sciences]

[Abstract] Single crystals of $CdInSbS_4$ were grown from brown powder of this compound by the method of chemical transport reactions in a horizontal bizonal furnace, with crystalline I_2 sublimated three times to chemical purity as carrier, after the compound had been synthesized in polycrystalline form by fusion of a stoichiometric mixture of the four elements, each at least 99.999% pure, under a vacuum of 0.1 Pa. The temperature inside the sealed transparent quartz crucible under a vacuum of 0.01 Pa was controlled within the 820-920 K range and that of the source within the 970-1070 K range. Structural examination under a microscope and x-radiographic analysis revealed octahedral crystals, the largest ones having been produced with the iodine concentration maintained at 3 mg/cm^3 and the two temperatures set respectively at 850 K and 990 K. Autodiffractometry with a Sintex $P2_1$ instrument and analysis of the Laue patterns revealed a $\frac{4}{3}$/mm symmetry: cubic symmetry with parameters α = 10.80(3)Å, V= 1260(1,5)Å^3, Z= 8. The temperature dependence of the electrical conductivity was found to have two linear ranges corresponding to an activation energy of 0.19 eV and 0.41 eV respectively. The current-voltage characteristic of an In-$CdInSbS_4$-In structure at room temperature was found to have three ranges: a linear initial range, a "three-halves power" intermediate range, and a "fourth power" final range. The fast nonlinear increase of current with increasing voltage is attributable to double injection. References 2: both Russian.

2415/12947
CSO: 1842/236

UDC 537.311.33

BEHAVIOR OF IMPURITY DURING RECRYSTALLIZATION OF PLASTICALLY DEFORMED SEMICONDUCTOR MATERIAL

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 22, No 5, May 86 (manuscript received 31 Aug 84) pp 736-740

[Article by R. S. Yerofeyev and E. I. Shcherbina, All-Union Scientific Research, Planning-Design, and Technological Institute for Current Sources]

[Abstract] Plastic deformation and electrophysical properties of an extrinsic semiconductor material were studied for the purpose of determining the cause of changes in these properties in the process from weak to strong deformation. The model material for the experiment selected was $Bi_2Te_{2.4}Se_{0.6}$ with 0.4 wt.% CdCl, known to almost completely recrystallize immediately during deformation. Blanks were annealed at 770 K for 100 h prior to single-pass extrusion, but not prior to double-pass and triple-pass extrusion so to avoid redistribution of the impurity. For comparison, rods of the extrinsic material were also produced from blanks by hot pressing and rods of the intrinsic material were produced from blanks by extrusion. Metallographic analysis has confirmed almost complete recrystallization of the extruded material, with a finer grain orientation after the second pass and hardly any grain orientation after the third pass. This, according to the results of x-ray spectral analysis, is attributable to segregation of grain sizes and precipitation of a second phase along grain boundaries with a lower Bi,Te content: evidently a new compound with higher concentration of impurity atoms. Electrophysical measurements revealed a decrease of the electron concentration after each successive extrusion pass, resulting in an increase of the Seebeck coefficient and a decrease of the electrical conductivity with almost no change in the electron mobility. For confirmation, specimens after extrusion were annealed first at 620 K and then at 670 K, for over 500 h in each case. Subsequent measurements of the Seebeck coefficient and the electrical conductivity indicated recovery and stress relief with relaxation at 620 K, dissolution of Cl beginning only after 500 h at this temperature but already after 250 h at 670 K with an attendant increase of the electron concentration. Evidently the second phase tends to regard recrystallization of extruded material and to decrease the electron mobility in it. Evidently after annealing extrinsic material is more nonhomogeneous than intrinsic material, Cd and Cl diffusing separately from the second phase so as to indicate that $CdCl_2$ exists in the $Bi_2Te_{2.4}Se_{0.6}$ solid solution in a dissociated state. The authors thank V. M. Chirkin for performing the x-ray spectral analysis. References 6: all Russian.

2415/12947
CSO: 1842/236

UDC 541.12.034.2:546.171.26.1

TURBOSTRATIC BORON NITRIDE AT HIGH TEMPERATURES AND UNDER HIGH PRESSURES

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 22, No 5, May 86 (manuscript received 18 Jul 84) pp 767-770

[Article by I. S. Gladkaya, G. N. Kremkova and V. N. Slesarev, High-Pressure Physics Institute imeni L. F. Vereshchagin, USSR Academy of Sciences]

[Abstract] An experimental study of BN turbostratic→cubic transformation was made, at high temperatures of 500-2500 K and under high pressures of 3-9 GPa. Both qualitative and quantitative impurity content before and after heat-pressure treatment (C only after, Mg, A1, Si, Ca, Fe, Cu) was determined on the basis of spectral analysis. Phase analysis after treatment was performed in a DRON-2 x-ray diffractometer with a CuK_{α}-radiation source. The transformation was found to begin under a pressure of 6 GPa at a temperature of 1250 K, a higher temperature threshold under this pressure having been established in the case of BN with a highly defective structure. A p-T diagram has been plotted on the basis of acquired data, including a transformation threshold line and a phase equilibrium line as well as an A-B-C line defining the region of coexistence of both phases. The data reveal also that under pressures below the transformation threshold ordering of the structure of turbostratic BN begins at 1000 K and is complete at 1550 K, transformation of three-dimensionally ordered turbostratic BN into cubic one under the threshold pressure of 6 GPa beginning only at 1800 K and only a wurtzite phase forming at temperatures below that. The cubic phase was found to form at a much faster rate from original turbostratic BN than from three-dimensionally ordered one. References 3: 2 Russian, 1 Western.

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UDC 666.117:537.226

PHASE DECOMPOSITION IN NIOBATE GLASSES AND ELECTROOPTIC EFFECT IN MATERIALS BASED ON SUCH GLASSES

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 22, No 5, May 86 (manuscript received 23 Jul 84) pp 827-830

[Article by I. P. Alekseyeva, G. O. Karapetyan, Yu. G. Korolev and L. V. Maksimov]

[Abstract] Heat treatment of niobate glasses for producing an electrooptic effect, despite the high Nb_2O_5 content making them highly crystallizable, was studied in an experiment with glasses of the $Na_2O - K_2O - Nb_2O_5 - SiO_2$ class with the two alkali oxides in a $[Na_2O]/[K_2O] = 1$ ratio and with up to 35 mol.% Nb_2O_5. Polyalkalinic material was selected, considering its wider temperature

range of glass transition with likely formation of $NaNbO_3$ and $KNbO_3$ microcrystals. Specimens synthesized in a platinum crucible at 1400-1500°C were annealed at approximately 550°C for 2 h, then again isothermally heat treated at various temperatures within the 600-900°C range for 2-10 h. The crystallization temperature of each component was determined on the basis of polythermal measurements and differential thermal analysis. Phase analysis of crystalline glasses was performed in a DRON-2 x-ray diffractometer with a CuK_α-radiation source, revealing only one crystalline phase: $NaNbO_3$ (lueshite). Fluorescence upon excitation by a CuK_β-radiation source was filtered through a nickel foil, widening of the x-ray lines serving as measure of average crystal dimensions. Absorption spectra were measured with a Unicam SP700 spectrophotometer. Considering that the intensity of Rayleigh scattering is determined by "frozen in" density and concentration fluctuations during fast isobaric cooling of the glass melt while the intensity of Mandel'shtam-Brillouin scattering is determined by adiabatic density fluctuations, both scattering spectra were measured and the Landau-Placzek ratio of the two intensities was used as measure of "freeze in" buildup. This ratio increased with increasing Nb_2O_5 content in the glass. Dielectric and electrooptical properties after the second isothermal heat treatment were measured at temperatures within the low-temperature peak on the differential-thermal-analysis curve, 17.5 Na_2O + 17.5 K_2O + 35 Nb_2O_5 + 30 SiO_2 glass having two exothermic peaks about 640°C and 900°C respectively. Heat treatment had increased the dielectric constant of these glasses from typically 20 to 100-160, while precipitating fine-disperse volume-wide crystallization with $NaNbO_3$ microcrystals of the 50 Å size fraction as the product. A square-law electrooptic effect with coefficients $R_{11}—R_{12}$ approximately $2 \cdot 10^{-21}$ cm^2/V^2 could be obtained in these glasses after heat treatment, with a transverse electric field of 10^4 V/cm intensity. References 9: 3 Russian, 6 Western.

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UDC 546.882—31'815—31'34—31'32—31

DIELECTRIC AND PIEZOELECTRIC PROPERTIES OF $K_{2+x}Li_xPb_{4-x}Nb_{10}O_{30}$ CERAMIC

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 22, No 5, May 86 (manuscript received 21 Aug 84) pp 841-845

[Article by V. P. Zavylov, V. D. Komarov, S. A. Kurkin, Ye. A. Alekhina and V. S. Filipyev, Rostov State University imeni M. A. Suslov and Scientific Research Institute of Physics]

[Abstract] A study of the quasi-binary system of two materials, piezoelectric $K_2Pb_4Nb_{10}O_{30}$ (rhombic structure, Curie point 723±10 K) and ferroelectric

$K_6Li_4Nb_{10}O_{30}$ (tetragonal structure at room temperature, Curie point 693 K) was made, for the purpose of determining the limit of their $(1-\frac{1}{4}x)K_2Pb_4NB_{10}O_{30}+\frac{1}{4}xK_6Li_4Nb_{10}O_{30}$ solid solutions and range of morphotropic phase transition as well the dependence of their electrophysical properties including dielectric permittivity and their curie point on the composition. Polycrystalline specimens of these solid solutions were produced from chemically pure K_2CO_3, Li_2CO_3, $PbCO_3$, and extra pure Nb_2O_5 by solid-phase synthesis. The optimum process temperature and time were within 1070-1370 K and 2-10 h, depending on the composition, as determined on the basis of control experiments and x-ray phase analysis. Ceramic material was produced by sintering at highest temperatures of 1270-1520 K and under pressures of $5\cdot10^6$-$5\cdot10^7$ Pa, with a holding time of 10-80 min at the highest temperature. Granulometric analysis under an electron microscope and crystallographic analysis in a DRON-2.0 x-ray diffractometer with filtered CuK_α-radiation revealed terminal solid solutions of the "tetragonal tungsten bronze" type over the $0 \leq x < 2.2$ range corresponding to a rhombic range and a tetragonal range separated by a morphotropic phase boundary at $x \approx 1.1$, the tetragonal $1.1 < x < 2.2$ range being characterized by an anomalous temperature dependence of dielectric permittivity with soft peaks at temperatures almost independent of the composition. Migration of Li^+ ions into the triangular channels of the tetragonal structure evidently causes blurring of the ferroelectric phase transition till the anomaly vanishes at the Curie point, while their migration into the rhombic structure decreases spontaneous strains and thus also spontaneous polarization with an attendant lowering of the Curie point. The lattice parameters of the tetragonal structure were found not to change with changing composition in the $x \geq 2.4$ range but to remain the same as with $x \approx 2.2$, this accordingly being the limit of the continuous solid-solution series. References 8: 2 Russian, 6 Western.

2415/12947
CSO: 1842/236

UDC 546.657:535.338.32

STIMULATED EMISSION OF RADIATION BY $Cd_{1-x}Sc_xF_{2+x}$ SINGLE CRYSTAL WITH Nd^{3+} IONS

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 22, No 5, May 86 (manuscript received 23 Apr 85) pp 873-875

[Article by A. A. Kaminskiy, A. A. Markosyan, A. V. Pelevin, Yu. A. Polyakova and T. V. Uvarova, Crystallography Institute imeni A. V. Shubnikov, USSR Academy of Sciences]

[Abstract] Single crystals of $Cd_{1-x}Sc_xF_{2+x}:Nd^{3+}$ with a fluorite structure have been produced for the first time by crystallization from the melt. Optical pumping of such a crystal stimulated emission of radiation at near-

infrared wavelengths in $^4F_{3/2} \rightarrow {}^4I_{11/2}$ and $^4F_{3/2} \rightarrow {}^4I_{13/2}$ channels of its activated ions. A subsequent experimental study has yielded the optimum ratio of ingredients, atmosphere, and rate of withdrawal from the crucible into the cold zone. Specimens of single crystals containing 2 wt.% Nd and 7-10 wt.% Sc+La were cut for spectroscopic analysis and laser experiments. The results revealed a characteristic disordering of the structure, but also an "ultraviolet turn-off" effect preventing stimulation of emission by an ISP-250 Xe flash lamp at temperatures below 200 K. References 8: 5 Russian, 3 Western.

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UDC 666.539

MECHANICAL PROPERTIES OF ELECTROCERAMIC MATERIALS EXPOSED TO NUCLEAR RADIATION

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 22, No 5, May 86 (manuscript received 8 Aug 84) pp 875-878

[Article by I. M. Blaunshteyn, M. B. Kishinevskaya, M. I. Muminov and V. P. Tibeykin, Nuclear Physics Institute, UzSSR Academy of Sciences]

[Abstract] Three commercial electrical-grade ceramic materials were tested for the effect of nuclear radiation on their Young's modulus of elasticity and internal friction. These materials were: MK, 99.0% corundum with aluminosilicate glasses; GB-7, 91-92% corundum with boroaluminosilicate glasses; and UF-46, 66-70% corundum or mullite with aluminosilicate glasses. These materials had been selected so as to cover a wide range of composition, grain size, and crystalline content. They were bombarded with neutrons to a maximum fluence of $5 \cdot 10^{23}$ m^{-2} at temperatures from room to 450°C. The modulus of elasticity was then measured by the resonance method, the internal friction being determined simultaneously from the proportional to it vibration attenuation factor. The results reveal that UF-46 ceramic is more resistant than the other two. The peaks on the temperature dependence of both mechanical properties of all three materials were found to become much softer after irradiation to the maximum fluence of $5 \cdot 10^{23}$ m^{-2}, indicating a homogenization of the material. References 6: all Russian.

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UDC 546.28'26

PREPARATION AND PROPERTIES OF β-SiC LAYERS ON SILICON AND QUARTZ SUBSTRATES

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 22, No 6, Jun 86 (manuscript received 17 Sep 84) pp 955-959

[Article by I. P. Akimchenko, L. M. Ivanova, A. A. Pletyushkin, E. M. Lazarev, A. V. Laptev and A. S. Gordeyev, Metallurgy Institute imeni A. A. Baykov and Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences]

[Abstract] Layers of β(cubic)-SiC were produced on substrates of Si single crystals and fused quartz, from the gaseous phase, by thermal decomposition of CH_3SiCl_3 in a H_2 atmosphere at various temperatures over the 800-1250°C range. The temperature was measured with an OPPIR-17 optical pyrometer without correction for emission of radiation, the deposition process lasting 20-30 min with the CH_3SiCl_3 concentration in hydrogen maintained constant at 0.05 g/dm³. The structure of the deposit was examined under a JSM-U3 scanning electron microscope in the secondary-electron mode, and was found to depend largely on the substrate temperature during the deposition process. Optical measurements were made for determining the transmission spectrum and the photo-e.m.f. spectrum over the 1200-600 cm^{-1} infrared and the visible range. The layer thickness was determined from the known absorption coefficient within the 800 cm^{-1} maximum-absorption (minimum-transmission) band of the transverse optical phonon in SiC, which yielded 8500 Å for a layer deposited at 900°C. The results also indicate formation of Si-O bonds responsible for another but much smaller absorption peak within the 1080 cm^{-1} band, their vibrations decreasing with higher deposition temperature. The photo-e.m.f. spectra of SiC/Si structures measured on both sides reveal existence of a heterojunction here, SiC layers on quartz being amorphous without photosensitivity when deposited at temperatures below 1000°C and microcrystalline with cubic lattice when deposited at temperatures above 1000°C. References 6: all Russian.

2415/12947
CSO: 1842/235

UDC 541.123.3

SPECTROSCOPY AND X-RADIOGRAPHY OF SiO_2-GeO_2 SYSTEM SPECIMENS PRODUCED BY SOL—GEL METHOD

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 22, No 6, Jun 86 (manuscript received 1 Oct 84) pp 966-968

[Article by B. Z. Shalumov, L. A. Zhukova, Ye. A. Ryabenko, N. G. Chernaya and Yu. V. Oboznenko]

[Abstract] Specimens of the SiO_2-GeO_2 oxide system were produced by the sol—gel method for x-radiography and infrared spectroscopy. Sols were

obtained by hydrolysis of $(C_2H_5)_4Si$ and $(C_2H_5)_4Ge$ and let spontaneously gellate. The gels were then heat treated for crystallization, specimens with 0-40 mol.% GeO_2 at 1370 K for 100 h and specimens with 40-100 mol.% GeO_2 at 1170 K for 100 h. Subsequent x-radiography revealed an α -cristobalite structure of SiO_2+ (0-10 mol.% GeO_2) solid solutions and a quartzitic structure of GeO_2 in the SiO_2+ (80-100 mol.% GeO_2) solid solutions, with both phases appearing in solid solutions of the intermediate SiO_2+ (10-80 mol.% GeO_2) range. The infrared spectra indicate a correlation with the lengths of Si-O and Ge-O bonds in the Si-O-Ge bridge as well as with their respectively high-frequency and low-frequency vibrations. References 10: 6 Russian, 4 Western.

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CSO: 1842/237

UDC 539.29.666

PRODUCING $BaTiO_3$ SEMICONDUCTOR CERAMIC BY DOPING FROM LIQUID PHASE

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 22, No 6, Jun 86 (manuscript received 16 Jan 84) pp 1004-1008

[Article by L. A. Belova, Yu. I. Goltsov, O. I. Prokopalo and I. P. Rayevskiy, Rostov State University imeni M. A. Suslov and Scientific Research Physics Institute]

[Abstract] Ceramic material was produced by sintering $BaTiO_3$ while adopting it with glass containing 1-5 mol.% oxide of a rare-earth or group-V,VI element from the liquid phase. For the experiment there was first used fusible $BaO-Ba_2O_3-WO_3$ glass, whereupon $A1_2O_3$ and SrO oxides were added for improving its chemical and crystallization stability. Subsequently SrO was replaced with CdO, PbO, MnO, or some other oxide, for regulation of the exchange processes in the liquid-phase/solid-phase system. The procedure, according to standard technology, included founding glass with a chemically pure oxide content in a platinum crucible at 1500-1600 K for 1 h and adding it to $BaTiO_3$ during sintering at 1400-1600 K. Transition of $BaTiO_3$ into the semiconductor state was found to begin at 1300 K and end at 1400 K, being completed within 3 h at 1400 K. Quantitative analysis of sintering and doping with WO_4 and Sm_2O_3 supports the results of measurement of the electrical resistivity over the 300-600 K temperature range in an electric field of 10-900 V/cm intensity, revealing that doping from the liquid phase can yield a much higher dopant concentration, far above the 0.1-0.3 mol.% range of electrical resistance anomaly, than doping from the solid phase and thus improves the semiconductor properties of the glass-ceramic $BaTiO_3$ material. This material has wider temperature and field-intensity ranges of its posistor effect, positive

temperature coefficient of electrical resistance, as well as a weaker field dependence of its electrical resistivity than plain $BaTiO_3$ ceramic material.

References 7: 4 Russian, 3 Western (2 in Russian translation).

2415/12947
CSO: 1842/237

UDC 621.762

DYNAMIC STRENGTH CHARACTERISTICS OF PERMEABLE FIBROUS MATERIALS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 6, Jun 86 (manuscript received 27 Sep 80) pp 92-97

[Article by A. A. Ivanchuk, D. M. Karpinos, Yu. V. Kondratyev, Yu. I. Nezhentsev, A. Ye. Rutkovskiy, V. Ya. Bikerniyeks, O. O. Peterson and V. A. Pekhovich, Institute of Materials Science Problems, UkSSR Academy of Sciences]

[Abstract] An experimental study of permeable fibrous materials was made, for the purpose of determining their dynamic strength characteristics dependent on the porosity. Selected as model material was one with wires of Cr18Ni9Ti steel woven into a "lasting" multilayer mesh with tricot binding. Such fabrics, with a porosity of 15%, 20%, 40%, 60%, 70% respectively, were produced by the standard cermet technology of cold pressing and subsequent sintering. Bar specimens 55 mm long and 10x10 mm^2 in cross-section, some smooth and others with a Mesnager notch, were tested in a "PSWO-30" impact machine with swinging pendulum and 40 mm between supports. The impact strength (maximum load prior to fracture), the compliance (maximum deflection), the ultimate energy resistance, the crack initiation work, and the crack propagation work were determined from the oscillograms of 3-point flexure in load-displacement coordinates. An analysis of the results on the basis of deformation and fracture theory for porous materials reveals that both impact strength and ultimate energy resistance or toughness increase with decreasing porosity, while the sensitivity to notching decreases with increasing porosity. These results differ from those for Mo-wire and W-wire fabrics, their toughness being maximum within the 25-30% porosity range. The results of this study must be treated as comparative ones only, considering that neither can a perfectly compact material be produced from fibers nor can a permeable porous metal be produced by casting and forming. References 5: all Russian.

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CSO: 1842/238

UDC 666.798.2

INTERRELATION BETWEEN ELECTRICAL CONDUCTIVITY OF SINTERED COMPOSITE MATERIALS AND DISPERSION OF ORIGINAL COMPONENTS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 6, Jun 86 (manuscript received 7 Feb 85) pp 97-101

[Article by Yu. P. Zarichnyak, S. S. Ordanyan, A. N. Sokolov and Ye. K. Stepanenko, Leningrad Technological Institute and Leningrad Precision Mechanics and Optics Institute]

[Abstract] The interrelation between electrical conductivity of a sintered composite material and dispersion of the original components is analyzed on the basis of experimental data pertaining to the NbN-AlN system, these two nitrides neither interacting with nor dissolving one another at temperatures up to 2000°C. The original NbN powder was either of the 60-80 μm grain size fraction from the Donetsk Chemical Reactants Manufacturing Plant or, after 20 h grinding, of the 0.25-1.0 μm grain size fraction. The original AlN powder was also either of the 80-100 μm grain size fraction from the Inorganic Chemistry Institute (LaSSR Academy of Sciences) or, after 10 h grinding, of the 0.25-1.0 μm grain size fraction. From these powders were produced five batches of composite with the ratio of AlN (dielectric) grain size to NbN (conductor) grain size ranging from 0.0006 to 150, with the AlN content ranging from below 20% to above 80%. Specimens for testing, 45 mm long and 5x5 mm^2 in cross-section, were produced by sintering at 1850°C in an atmosphere of extra-pure N_2 under a pressure of 130 kPa for 1 h. The electrical resistance was measured by the 4-point current-voltage method, accurately within 4%. The specimens differed in porosity, pores constituting an extra dielectric "phase", which had to be corrected for according to the formula $\rho_{true} = \rho_{meas}$ $(1- II)^{3.5}$ (ρ - electrical resistivity, II- porosity,%). The results of these measurements and of microstructural examination reveal that, while the electrical resistivity increases with increasing AlN content in the composite, it increases more appreciably with decreasing ratio of AlN grain size to NbN grain size. It therefore is feasible to widely regulate the electrical resistivity or conductivity of the NbN-AlN composite system by grain size control, also the threshold NbN content above which the electrical conductivity increases steeply. References 12: 9 Russian, 3 Western (1 in Russian translation).

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UDC 621.315.592:546.78

SEMICONTINUOUS PROCESS OF GROWING Si SINGLE CRYSTALS

Moscow TSVETNYYE METALLY in Russian No 7, Jul 86 pp 73-74

[Article by V. I. Batashev, Ye. P. Levshin, Kh. I. Makeyev, L. M. Rashutina, I. D. Ryabukhina and Yu. M. Shashkov]

[Abstract] Growing single crystals by the semicontinuous version of the Czochralski method involves successive cycles of ingot pulling from the crucible for transfer to a special chamber, crucible refill with stock material for melt-down, and ingot reinsertion for further growth. A study of this process was made, for the purpose of determining its adaptability to economical production of large Si single crystals. A crucible was charged with 10-12 kg polycrystalline Si, then vacuumized, and placed in an Ar gas stream. After about 2/3 of the melt had solidified, the ingot was broken away and rapidly pulled through an open gate into the upper chamber. The gate was then closed again and the ingot was removed from the upper chamber, where it was replaced with a polycrystalline rod which had been produced by reduction of SiO_2 with hydrogen. The upper chamber was then closed and vacuumized, whereupon the gate was opened for dropping the rod into the crucible below and melting about 2/3 of it. The remainder was pulled into the upper chamber, the gate was closed, the lid on the upper chamber was opened, and the makeup ingot was replaced with a seed crystal. Both heating and cooling during the process were monitored with a set of VR-5/VR-20 thermocouples with quartz sheaths measuring the temperature of the crucible at key locations. The temperature of the crucible wall was found to reach 1650°C. The process yielded three single crystals 80 mm in diameter, twice as heavy as those produced by single pulling operation. Their electrical resistivity was high, with a longitudinal profile identical to that in conventionally grown Si single crystals. The oxygen concentration was found to decrease along a single crystal, just as in a conventionally grown one, but to become lower throughout after each successive pulling and melting cycle. References 2: 1 Russian, 1 Western.

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CSO: 1842/246

UDC 541.12.034.2

ALKALI METAL HYDROFLUORIDES AS CATALYSTS FOR THE SYNTHESIS OF β-BN

Kiev SVERKHTVERDYYE MATERIALY in Russian No 4, Jul-Aug 86 (manuscript received 30 May 85) pp 3-6

[Article by O. A. Zanevskiy, K. P. Burdina, L. G. Sevatyanova and Ya. A. Kalashnikov, Moscow State University]

[Abstract] An analysis was conducted on the synthesis of β-BN catalyzed by Li, Na, or K hydrofluorides, with the P-T diagrams demonstrating definite

differences with P-T plots obtained with metal fluoride catalysts. The formation of β-BN in the presence of the hydrofluorides required lower pressure and temperature than reactions initiated by the fluorides, but a higher pressure and lower temperature than when magnesium nitride is used for initiation. X-ray phase analysis and IR spectroscopy were consistent with the assumption that the cubic BN was synthesized by α-to-β transformation initiated by NH_4BF_4. References 13: 3 Russian, 10 Western (1 in Russian translation).

12172/12947
CSO: 1842/262

UDC 666.233

ELECTRONIC STRUCTURE OF METALS IN GRAPHITE TO DIAMOND TRANSFORMATION

Kiev SVERKHTVERDYYE MATERIALY in Russian No 4, Jul-Aug 86 (manuscript received 25 Jun 85) pp 6-8

[Article by T. D. Varfolomeyeva, L. A. Ivanov, A. V. Tsvyashchenko and Ye. N. Yakovlev, High Pressure Physics Institute, USSR Academy of Sciences, Troitsk, Moscow Oblast]

[Abstract] To better define the parameters involved in the transformation of graphite into diamond, transformation studies were carried out under pressures of 6.5-8.0 GPa and temperatures of 1400-1500°C with alloy and metal mixture catalysts. With Cu_3Al alloy (25 at% Al) or 60 at% Cu (a = 0.3615 nm) and 40 at% Al (a = 0.4050 nm) powder mixture alloy-covered diamonds were synthesized. Diamonds were not obtained at temperatures below 1700°C or pressures below 6.5 GPa. X-ray phase analysis and electron microscopy demonstrated that at lower temperatures only alloys based on solid copper solutions that contain at least 15-20 at% Al function as catalysts. A reduction in the aluminum concentration diminished the concentration of crystallization centers and reduced the rate of transformation. The electronic structure of the Cu-Al alloy under conditions of high temperature and pressure was analogous to that of group VIII metals. References 10: 4 Russian, 6 Western (1 in Russian translation).

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UDC 666.233:542.9

SOLUBILITY OF METAL COMPONENTS OF DIAMOND-CONTAINING MATERIALS

Kiev SVERKHTVERDYYE MATERIALY in Russian No 4, Jul-Aug 86 (manuscript received 26 Apr 85) pp 9-11

[Article by G. P. Bogatyreva, V. B. Kruk and I. I. Kusyak, Superhard Materials Institute, Ukrainian SSR Academy of Sciences, Kiev]

[Abstract] An analysis was conducted on the dissolution of the metallic components of diamond-containing materials in HC1 at temperatures of 35-105°C for various periods of time. The materials differed in the content of Ni, Mn and Cu, and the concentration of products formed by their interaction with carbon. Maximum reaction was obtained at 105°C, as expected, and a polynomial mathematical model was derived. The mathematical model, based on empirical data, may then be used to determine optimal conditions for the HCe solubility of metal components in such materials. References 2: both Russian.

12172/12947
CSO: 1842/262

UDC [538.69:539.124.14]:666.233+548.73:666.233

SUBSTRUCTURE AND PHASE COMPOSITION OF NATURAL DIAMONDS CONTAINING LONSDALEITE

Kiev SVERKHTVERDYYE MATERIALY in Russian No 4, Jul-Aug 86 (manuscript received 14 Mar 85) pp 12-15

[Article by Yu. I. Sozin, Yu. I. Nikitin and V. G. Poltoratskiy, Superhard Materials Institute, Ukrainian SSR Academy of Sciences, Kiev]

[Abstract] Various samples of natural diamonds with lonsdaleite were studied as to substructure and phase composition in relation to graininess (-40 to +200). Microscopic examination and analysis of diffraction lines and phase compositions demonstrated that the internal structure of lonsdaleite is much more distorted than that of diamond. The dislocation density in the former was on the order of 1.3×10^{14} cm^{-2}, and in the diamond 2.1×10^{12} cm^{-2}. Analysis of the graphite, diamond and lonsdaleite components showed that greater graininess was accompanied by some decrease in the lonsdaleite fraction. The latter observation was ascribed to the greater susceptibility of lonsdaleite to heat and the slower cooling of the large granule samples. The abrasiveness of the natural diamonds with lonsdaleite was 2- to 3-fold greater than that of synthetic diamonds and attributed to the substructural characteristics of the former. References 12: 9 Russian, 3 Western.

12172/12974
CSO: 1842/262

UDC 666.233.666.3

LOW TEMPERATURE ANNEALING OF POLYCRYSTALLINE DIAMOND

Kiev SVERKHTVERDYYE MATERIALY in Russian No 4, Jul-Aug 86 (manuscript received 27 Nov 84) pp 15-18

[Article by S. M. Rotner, Yu. M. Rotner, L. A. Peregudova and Ye. N. Gruzdeva, Odessa State University]

[Abstract] An evaluation was made between the electrical resistance of OKMAL diamond showing p-type conductivity and the degree of oxidation. Samples that were annealed at 200-300°C for 3 h in air were found to undergo a variety of physical changes, as well as an increase in resistance by six to eight orders of magnitude. However, annealing in vacuo did not lead to an increase in resistance. The change in resistance was attributed to oxidation of amorphous carbon, its destruction, increased porosity, and breakdown of the polycrystalline diamond structure into individual grains. References 2: both Russian.

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UDC 546.26-162.02

REFLECTION SPECTRA OF CARBON COATINGS

Kiev SVERKHTVERDYYE MATERIALY in Russian No 4, Jul-Aug 86 (manuscript received 18 Jun 85) pp 18-21

[Article by S. I. Vakula, V. G. Padalka, V. Ye. Strelnitskiy and A. I. Timoshenko, Kharkov Physical Technical Institute, Ukrainian SSR Academy of Sciences]

[Abstract] Reflection spectra and refractive indexes for different types of carbon coatings were analyzed to define structural parameters in such carbon films. Studies with two types of diamond-like condensates prepared by different methods--one with a density of 2.4 ± 0.2 g/cm^3 and a resistance of 10^5 ohm·cm, and the other with a density of 3.4 ± 0.2 g/cm^3 and a resistance of 10^{10} ohm·cm--demonstrated that the primary structural elements consisted of a two-dimensional graphite-like network with sp^2 hybridization of valence electrons. The reflection coefficients at 0.4-0.6 μm wavelengths for 0.38 and 1.00 μm thick films were virtually identical. With an increase in the coating thickness to 4.5 μm the reflection coefficient showed a continuous decrease, and the refractive index showed an anomalous behavior. The latter was interpreted to indicate a difference in ordering from largely tetrahedral at h = 0.35 μm, to trigonal (graphite-like) at h = 4.5 μm. References 6: 5 Russian, 1 Western.

12172/12947
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UDC 666.046.558.28

MICRODUCTILITY OF TITANIUM CARBIDE PRODUCED BY HIGH PRESSURE SINTERING

Kiev SVERKHTVERDYYE MATERIALY in Russian No 4, Jul-Aug 86 (manuscript received 23 Sep 85) pp 21-25

[Article by P. S. Kislyy and L. F. Stasyuk, Superhard Materials Institute, Ukrainian SSR Academy of Sciences, Kiev, and V. S. Neshpor, All-Union Scientific Research Institute of Abrasives and Burnishing, Leningrad]

[Abstract] An analysis was conducted on the microductility of titanium carbine samples prepared by sintering at temperatures of 1400-1800°C and pressures of 25.5, 42.3 and 70.0 kBar (4 min isothermic holding times). The resultant data provided by the various testing procedures demonstrated that microductility increases with a decrease in the carbon concentration in the homogenous region, as well as with an increase in temperature and pressure. Strain hardening rendered microductility independent of the carbon content when the C/Ti ratio was below 0.8. References 11: 10 Russian, 1 Western (in Russian translation).

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CSO: 1842/262

UDC 622.233.051.7:666.233

DRILL BITS MADE FROM TUNGSTEN-FREE DIAMOND MATERIAL

Kiev SVERKHTVERDYYE MATERIALY in Russian No 4, Jul-Aug 86 (manuscript received 12 May 85) pp 34-37

[Article by R. K. Bogdanov, E. D. Kizikov and N. F. Golod, Superhard Materials Institute, Ukrainian SSR Academy of Sciences, Kiev]

[Abstract] Graphical and tabulated results are presented on various testing procedures used in assessing drill bits produced from a tungsten-free diamond-based material designated KIAM. Such bits were found suitable for drilling in a variety of ores, with particularly satisfactory results obtained with drill bit BA10. The wear resistance of the BA10 was generally 1.7- to 3.1-fold greater than that of conventional bits, drilling rate was 1.1- to 1.4-fold faster, and the diamond content utilized was 1.2- to 1.4-fold lower. These findings provide further confirmation for the contention that the less expensive KIAM material can be used for the production of drill bits that are, in general, more cost-effective than those manufactured from tungsten-containing materials.

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CSO: 1842/262

PREPARATION

RECOMMENDATIONS FOR IMPROVING NONFERROUS SCRAP QUALITY OUTLINED

Moscow EKONOMICHESKAYA GAZETA in Russian No 31, Jul 86 p 17

[Article by A. Mokeichev, chief of USSR Ministry of Nonferrous Metallurgy's State Inspectorate for Nonferrous Metals: "Poison and Antidote;" text in slantlines is printed in screened box]

[Text] /I somehow overheard at a meeting that colleagues from ferrous metallurgy have declared copper a poison. At first I was indignant: so valuable a metal a poison! Then I thought, for ferrous metallurgists it is indeed. An admixture of copper in ferrous metals degrades their quality. Moreover, steel's copper content is rising year after year.

I remembered all this after I had become acquainted with an article "Eenie Meenie Minie Moe" (EKONOMICHESKAYA GAZETA No. 30). The quality of metal smelted from scrap directly depends on how waste collection is organized. And today it is far from perfect./

In 1985, the State Inspectorate for Nonferrous Metals surveyed 360 enterprises. All exhibited the same deficiencies in procuring and storing nonferrous scrap as at Dinamo (this has been discussed in EKONOMICHESKAYA GAZETA). Nonferrous metals are transported to a dump, are littered with trash, and are mixed according to grades and types with ferrous metal wastes. Old scrap is not accounted for anywhere, and the bookkeeping is in a sorry state.

Managers were punished for violation of the procedure for collecting nonferrous metal scrap. The heads of the appropriate ministries and departments were informed of the shortcomings discovered.

However, the situation has not greatly improved. As before, more than 60 percent of copper and aluminum wastes and 70 percent of brass and bronze wastes reach Vtortsvetmet [State Trust for the Procurement and Processing of Secondary Nonferrous Metals] mixed as to types and grades and with ferrous metal inclusions or trash. These wastes cannot be used to produce high-quality alloys. Therefore, copper wastes go to produce blister copper; aluminum wastes--to reduce steel. All alloying additives are lost. As a result, more than 35,000 tons of tin, zinc, lead, and other nonferrous metals annually are eliminated from the production cycle.

Today, unfortunately, there are no economic levers to guarantee complete, high-quality procurement of all scrap or to reduce irreversible losses.

High-quality waste collection primarily depends on who is directly processing nonferrous metal. But a machine-tool operator is not obligated to collect chips. Standards for machine-tool work time approved by the USSR State Committee for Labor and Social Problems provide for these operations: receive the order, adjust the equipment, deliver the finished part to the warehouse.... Wastes are mentioned only occasionally: "If necessary, remove chips from the jig." But nothing is said about the fact that it must be collected without permitting pollution and losses. The worker reports only that a part has been made, while he should send the Quality Control Department both the finished part and properly collected wastes suitable for further use.

Enterprises have no material incentive to procure scrap. A maximum of 4.5 percent of the sum obtained for scrap delivered is transferred to their bonus fund, and one-fourth of it is transferred to the state budget. A worker at such an enterprise can count on a 1.4-ruble bonus per month, which is a questionable incentive. At enterprises where a particularly large number of nonferrous metals are processed, the bonus fund is somewhat higher, but it is also inadequate to provide significant motivation.

We feel that enterprises must encourage both a reduction in metal consumption and more complete use of wastes in production.

In machine-building, more than 22 percent (and in some places, more than 30 percent) of nonferrous metals end up as chips. This is too much. As compared with 1980, their utilization factor has dropped, especially in the electrical engineering and instrument making industries.

Irrecoverable losses to scale and burning are high. They constitute 20 percent in individual production facilities, while the norm is up to 9 percent. Scarce metals are generally not extracted from slurries from galvanizing operations. For example, the Moscow GPZ-1 [State Bearing Plant] loses about 80 tons of zinc per year due to the lack of an effective dust collection system.

According to calculation by specialists from the USSR Ministry of Nonferrous Metallurgy, it is economically worthwhile to transfer up to 70 percent of the savings obtained by a reduction in unit nonferrous metal consumption and 50 percent of the value of previously irrecoverable wastes brought into production to an enterprise's incentive fund. The bonus should be paid from the sums obtained from selling scrap, regardless of the relationshp of labor productivity and wages. A similar bonus system is being used at metallurgical enterprises, where it encourages metal savings through work at minus tolerances (production of lighter-weight articles). It has thoroughly proven itself.

Naturally, these measures require additional material expenditures, but the national economy as a whole will recover them in the form of reduced expenditures to extract primary raw materials. To produce nonferrous metals from ores in the amount obtained from wastes in the past year alone would require additional billions of rubles in capital investment.

The evaluative indicators of enterprises are in no way dependent on the quality and quantity of the scrap they receive. I think that USSR Gosplan and the USSR Ministry of Finance must develop instructions on a procedure for accounting for nonferrous metal wastes as part of the sold and marketable output (as with ferrous metals). Heads of enterprises must have the capability to spend most of the sum obtained by selling scrap on technical measures to improve its procurement.

To be sure of the effectiveness of the measures proposed, it makes sense to conduct an experiment at several electrical equipment, automotive industry, agricultural machine-building, and nonferrous metallurgy plants in 1978-1990. During the experiment, economic levers encouraging scrap procurement will be finalized.

A major obstacle to scrap procurement has become planning "according to what has been achieved," or, as it is delicately called, "according to the facts." As a result, some enterprises, admittedly few, have excessive assignments.

Not long ago I myself was a plant director, and I know well how difficult it is to prove that a plan is unrealistic. The scrap-formation balance sheet which we compile annually helped. This balance sheet should become the basis for planning scrap procurement. Despite the gradual increase in plans, most enterprises now have reduced assignments.

Thus, the plan for the Tyumen Battery Plant (Ministry of the Electrical Equipment Industry) to deliver lead wastes was reduced by 172 tons, and the Yerevan Machine-Tool Building Plant imeni Dzerzhinskiy's assignment for procuring scrap was halved.

Last year the Irbit Motorcycle Works (Sverdlovsk Oblast) received a noticeably easier plan. What measures did the Ministry of the Automotive Industry take this year? Again the goal was reduced. The examples could continue.

It is quite obvious that the best alternative is to ship prepared scrap from enterprises where it is formed immediately to metallurgical plants (so-called direct shipments), not to Vtortsvetmet bases. However, scrap procurers receive bonuses depending on the amount of scrap they process. Therefore, Vtortsvetmet does not make serious efforts to have suppliers directly ship scrap in good condition. The material incentive to Vtortsvetmet workers should depend on the total amount of scrap procured, including what is directly shipped. In my opinion, the specific amount of the delivery of high-quality scrap as part of the total amount procured should become the funding indicator for Vtortsvetmet.

There is one more important problem: procurement of old scrap.

Copper enters ferrous metal primarily from this scrap. Therefore, all equipment written off at an enterprise should be dismantled and the parts made of nonferrous metals removed. But this is done very little. Reference is usually made to the time the work takes and the scarcity of repair personnel. Written-off equipment is shipped to Vtorchermet [State Trust for the Procurement and Processing of Secondary Ferrous Metals] with all assemblies and parts.

Vtorchermet should not accept it in this form. It has been authorized to use penalties equal to half the value of the entire lot of scrap. But, as checks of the Dnepropetrovsk, Kuybyshev, and many other Vtorchermet enterprises show, the presence of nonferrous metal in the scrap is not indicated even in the documents. Vtorchermet is preoccupied with fulfilling its own plan and is not distracted by "trivia."

The result--every year, more than 35,000 tons of copper and 20,000 tons of other nonferrous metals enter steel. At the Uzbek Metallurgical Plant alone, up to 25 percent of the melts have an elevated content of these elements. There is now more copper in ferrous metals than in copper ore.

In the near future, all growth in steel smelting is to be accomplished with old scrap. The situation as it is cannot remain unchanged.

There seems to be a simple solution: Along with increasing quality control over ferrous metal scrap delivery, establish that component-supplier organizations can deliver equipment to enterprises only after they have produced a Vtortsvetmet certificate that the plan for delivering old scrap for the reporting period has been fulfilled.

12809/12947
CSO: 1842/251

UDC 541.18.02.182.72.-492.2

STRUCTURE OF ULTRAFINE-DISPERSE NICKEL PRODUCED BY THERMOLYSIS OF $Ni(HCOO)_2$ COMPLEXES WITH $N_2HCH_2CH_2OH$

Kiev POROSHKOVAYA METALLURGIYA in Russian No 5, May 86 (manuscript received 13 Jun 85) pp 1-5

[Article by M. M. Khvorov, Yu. I. Khimchenko (deceased) and A. K. Dudchenko, Colloidal Chemistry and Hydrochemistry Institute, UkSSR Academy of Sciences]

[Abstract] Ultrafine-disperse nickel was produced by thermolysis of $Ni(HCOO)_2$ complexes with $N_2HCH_2CH_2OH$ in a glass reactor, under standard conditions in air at a temperature of 498±5 K, using mixes of Ni^{2+}:$N_2HCH_2CH_2OH$= 1:3, 1:5, 1:50 and letting them react for 1 h ± 10 s. The powder was centrifuged and washed with ethanol, then ultrasonically treated in ethanol for structural examination of its particle under a UEMV-100 electron microscope. Analysis of bright-field and dark-field electron diffractograms, statistical analysis and histograms based on "Sorptomatica" dispersion analyzer (NEOLAB, Italy) data, and analysis of the crystallization process from the standpoint of equilibrium thermodynamics and the Gibbs-Wolf principle reveal fractions of stable submicron single crystals faceted and with organic film coating, small aggregates of such crystals, and large globules, also hexahedral and trihedral crystals shaped by the reactor walls. References 8: all Russian.

2415/12947
CSO: 1842/239

UDC 621.762

PRODUCTION OF FINE-DISPERSE TIN POWDER WITH VARIOUS DEGREES OF PURITY

Kiev POROSHKOVAYA METALLURGIYA in Russian No 5, May 86 (manuscript received 2 Jul 85) pp 7-9

[Article by A. D. Styrkas and R. A. Oganyan, Solid State Physics Institute, USSR Academy of Sciences]

[Abstract] Considering that mechanical comminution of solid tin into powder for the bearing industry is technologically inefficient and requires use of

surfactants for preventing aggregation of powder particles into lumps, while atomization of liquid metal pneumatically by means of an air jet yields a dimensionally very nonhomogeneous product, pneumoacoustic atomization of liquid metal by means of a cold ultrasonic air stream was studied for the purpose of comparative product evaluation. Fine tin powder was obtained with an ultrasonic nozzle operating at a frequency of 14-15 kHz and developing a sound pressure of 173-175 dB within the pulverization zone. A stream of air at 293 K was passed through a melt of 0000 extrahigh-purity tin at 723 K. The size distribution of the powder product was checked by sieve analysis and found to be within the fine fraction. Its purity was checked on the basis of the ratio of electrical resistance at room temperature and at 4.2 K respectively. The electrical resistance was measured on compact specimens of polycrystalline "balls" 7-8 mm in diameter. The ratio was found to be 2000-5000, an indicator of high purity, much higher than 600-800 in the case of mechanically pulverized tin. The ratio is 40,000 for 0000 extrahigh-purity solid tin, some contamination of powder being caused by the air stream and by contact with equipment made of other materials. References 6: all Russian.

2415/12947
CSO: 1842/239

UDC 661.883.1:661.888.2

GASSING OF ZrC, NbC, TaC POWDERS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 5, May 86 (manuscript received 10 Jul 85) pp 9-14

[Article by A. V. Makeyev, V. V. Khromonozhkin, A. S. Maskayev and V. G. Vilchinskiy, Podolsk]

[Abstract] An experimental study of ZrC, NbC, TaC refractive carbide powders was made, particularly concerning their gas content acquired through contamination during various stages of their production. Specimens were produced by mixing oxide with lampblack carbon for 24 h in a mortar containing $CH.CC1_3$ 2% paraffin, drying in air for 5 h, sifting, compacting into 10-12 mm thick disks 25 mm in diameter, carbothermal reduction in a vacuum furnace with a graphite heater at 2100°C for 2 h, crushing, grinding in a hard-alloy crucible for 10, 30, 50 h in an atmosphere of Ar, water, air, or $CH.CC1_3$, and vacuum annealing of some specimens under a pressure lower than $1 \cdot 10^{-3}$ Pa at 1200°C for 1 h or at 1600°C for 5 min. Gassing was monitored in a high-vacuum high-temperature apparatus with an oilless pumping system (electric-discharge pump, diffusion pump with nitrogen trap), an IPDO-2A mass-spectrometer, a set of Pt/PtRh thermocouples, a set of PMI-2 pressure transducers, a tungsten heater plate with control for quasi-linear temperature rise or isothermal heating, and a magnetic specimen manipulator. Measurement and calculation of the gassing kinetics, namely of the gassing rate as a function of time and temperature, together with stoichiometric analysis of the surface reactions $MeC + H_2O \rightarrow Me_xO_y + CO + H_2\uparrow$ and $MeC + H_2O \rightarrow Me_xO_yC_z + H_2\uparrow$ (Me= Zr,Nb,Ta), reveal that the

gas content increases, though not linearly, with longer grinding time and thus smaller grain size with larger specific surface area. It does not significantly depend on the grinding atmosphere, but is somewhat lower after grinding in argon. While generally ZrC powder gasses less than NbC powder under the same conditions, least oxygen is contained in TaC powder. The gassing rate can be minimized by vacuum annealing till it reduces the oxygen content to equilibrium level. References 6: 4 Russian, 2 Western (1 in Russian translation).

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UDC 661.55

INTERACTION OF TITANIUM AND NITROGEN DURING RADIATIVE HEATING

Kiev POROSHKOVAYA METALLURGIYA in Russian No 5, May 86 (manuscript received 29 May 85) pp 25-27

[Article by I. N. Frantsevich (deceased), L. A. Grishnova and V. L. Tikush, Problems Materials Science Institute, UkSSR Academy of Sciences]

[Abstract] Beneficial interaction of rarefied molecular and then ionized nitrogen with gray titanium was successfully obtained by radiative heating of the Ti surface. The molecular nitrogen was 99.995% pure and was ionized by means of a high-frequency electric discharge. Nitridation of titanium by molecular nitrogen began at a temperature of 500°C, reached after 2-3 min and measured with a Pt/PtRh thermocouple accurately within $\pm$10°C. Electron diffractograms revealed at 5 μm thick light-golden TiN surface layer and a diffusion zone underneath. With ionized nitrogen such a layer without cracks and pores began to form at 200-400°C already, its thickness increasing from 0.5 μm to 2 μm at 600°C, while the thickness of the diffusion zone increased from 10 μm to 30 μm at 600°C. Phase analysis of the diffusion zone revealed an α -phase (solid solution of N_2 in Ti) and an (Ti_2N)-phase, but the latter only after radiative heating with ionized nitrogen to 800°C. Radiative heating, therefore, intensifies nitridation of titanium and produces a thicker TiN surface film with a lower residual N_2 concentration in the diffusion zone, where the N_2 mobility is low. The effect of radiation is not only ionization of nitrogen but also tunneling, upon its absorption by the Ti crystals, of electrons from the valence band through the surface barrier to unfilled surface levels. References 6: all Russian.

2415/12947
CSO: 1842/239

UDC 621.793:669.018.45

PHASE-STRUCTURE CHARACTERISTICS AND PHYSICOMECHANICAL PROPERTIES OF Al_2O_3-TiO_2 COATINGS PRODUCED BY DETONATION METHOD

Kiev POROSHKOVAYA METALLURGIYA in Russian No 5, May 86 (manuscript received 7 Feb 85) pp 59-64

[Article by V. K. Fedorenko, V. D. Tkachenko, R. K. Ivashchenko, V. V. Remeslo, B. K. Lupin and N. P. Moskalenko, Institute Materials Science Problems, UkSSR Academy of Sciences]

[Abstract] Production of 60 wt.% Al_2O_3+ 40 wt.% TiO_2 powders as well as their phase structure and mechanical characteristics were studied for the purpose of optimizing their deposition on various substrates by the detonation method. Powders were produced by the mechanical method of grinding the ingredients, analytically pure Al_2O_3 powder of the 40-63 μm grain size fraction having been annealed at 1700°C for 1 h, and by the chemical method of crystallizing a mixture of given composition and crushing the thus presynthesized ingot. One of the latter batch had been sintered in a reducing H_2 atmosphere at 1700°C for 2 h and, after comminution, been classified by the method of pneumatic separation. Crystallization of the melt in a cold crucible, after fusion in a 60 kW high-frequency induction furnace, yielded a better powder for coating. Phase analysis in a DRON-1.5 x-ray diffractometer with a CuK_α-radiation source revealed α-Al_2O_3, γ-Al_2O_3, δ-Al_2O_3, TiO_2 (rutile) in both powders, also Ti_3O_5 in chemically produced powder after sintering in a reducing atmosphere. Detonation causes changes in the phase composition such as α-$Al_2O_3 \rightarrow \sigma$-$Al_2O_3$ transformation and formation of up to 15% beneficial Al_2TiO_5 in the detonation layer at high temperature. Addition of TiO_2 to Al_2O_3 was found to generally improve the mechanical characteristics of coatings, those made of powder produced by the chemical method being much more homogeneous and structurally uniform. While Al_2TiO_5 tends to blur grain and layer boundaries, detonation stabilizes its crystal lattice by way of an $\alpha - \beta$ phase transformation. The effect of these AT-40 coatings on the substrate metal they protect is selective, their adhesion to Cr (stainless steel) being anomalously strong and then stronger to Ti than to other metals and alloys. They lower the flexural strength of Al and brass but not of stainless steel, which they only embrittle, and not of low-carbon steel, which they even slightly strengthen. They lower the plasticity of Ti and stainless steel, but raise the proportional limit of low-carbon steel. References 8: 5 Russian, 3 Western.

2415/12947
CSO: 1842/239

UDC 621.762:620.22

DEVELOPMENT OF CORROSION-RESISTANT COMPOSITE MATERIALS WITH WC AS BASE AND P-Cr18Ni15 STAINLESS STEEL AS BINDER

Kiev POROSHKOVAYA METALLURGIYA in Russian No 5, May 86 (manuscript received 24 May 84) pp 69-75

[Article by V.P. Bondarenko and A. Yu. Ganopolskiy, Superhard Materials Institute, UkSSR Academy of Sciences]

[Abstract] A new series of composite materials has been developed for equipment operating with dissociable N_2O_4 coolant. They consist of powder-metal Cr18Ni15 stainless steel and WC binder in ratios 6:94 (WSS6), 20:80 (WSS20), 32:68 (WSS32) respectively. They are produced by grinding and mixing in a ball mill with a benzene solution of synthetic caoutchouc added as plasticizer, compaction into bars typically 35 mm long and 5x5 mm^2 in cross-section, and initial sintering in a hydrogen atmosphere followed by final sintering under vacuum. In the experimental stage of the development sintering was done at 1473 K, 1523 K, 1573 K, 1623 K, 1673 K, 1723 K, 1773 K for 30 min at each temperature and also at 1473 K for 1 h. They were tested for mechanical characteristics including density and porosity as well as flexural strength and Rockwell A hardness. Their phase equilibria were established on the basis of differential thermal analysis over the 1273-1773 K temperature range. Their corrosion resistance in HNO_3 concentrate was measured in 24 h tests at 295 K and in 2 h tests at 373 K, their corrosion resistance in N_2O_4 + 4% HNO_3 was measured in 360 h tests at 295 K. Metallographic and phase analysis revealed existence of the η_1(W_2C)-phase with $(Cr,Fe,Ni,W)_3C$ carbides in all three materials. The results of mechanical tests indicate that both the strength and the hardness of WSS20 and WSS32 are determined largely by the η_1-phase content, with the hardness but not the strength also depending on the P-Cr18Ni15 binder content. The composites WSS20 and WSS32 sintered at the solidus temperature of the WC — (P)Cr18Ni15 system, and thus at the end of compaction with a still negligible rate of η_1-phase formation, were found to have the best mechanical characteristics and the highest corrosion resistance in N_2O_4 + 4% HNO_3. References 14: 12 Russian, 2 Western.

2415/12947
CSO: 1842/239

UDC 621.762

CHARACTERISTICS OF TiC PRODUCED BY FUSION OF TiO_2+ C

Kiev POROSHKOVAYA METALLURGIYA in Russian No 6, Jun 86 (manuscript received 21 Jan 85) pp 1-4

[Article by A. B. Lyashchenko, B. V. Khayenko, L. S. Yershova and E. T. Kachkovaskaya, Institute of Materials Science Problems, UkSSR Academy of Sciences]

[Abstract] A new method of producing TiC powder has been developed, namely fusion of TiO_2 together with soot mixed in a whirler and subsequent comminution of ingots weighing 1-1.5 kg. Chemical analysis has established that the optimum mix ratio will yield TiC with 19.8-20.5% C_{total} including 0.16-1.2% C_{free}, 0.2-0.6% O_2, and 78.9-80% Ti. Microstructural examination and phase analysis in a camera with filtered CuK_o-radiation revealed significant differences between this TiC-1 monophasal equiatomic powder and TiC-2 standard mechanically produced powder, owing to the differences between the two technological processes. Mechanical tests revealed a dependence of the mean strength indicator on the grain size, linear up to the 1 mm fraction, the strength of TiC-1 powder with a monolithic macrostructure being approximately equal to that of ASS diamond powder of the -1 +0.8 mm grain size fraction and up to twice as high as that of standard TiC-2 powder. References 9: 8 Russian, 1 Western (in Russian translation).

2415/12947
CSO: 1842/238

UDC 621.762

DEPENDENCE OF PROPERTIES OF SP-40Ni3Mo POWDER STEEL ON CARBURIZATION METHOD

Kiev POROSHKOVAYA METALLURGIYA in Russian No 6, Jun 86 (manuscript received 5 Nov 85) pp 35-38

[Article by T. P. Moskvina, A. P. Gulyayev and G. N. Morgun, Central Scientific Research Institute of Ferrous Metallurgy]

[Abstract] A comparative study of SP-40Ni3Mo powder steel and conventionally smelted 40Ni3Mo steel was made, the powder steel being produced either from an alloy powder with carbon or from a mechanical mixture of carbon-free alloy powder and graphite. Each powder was compacted by hot pressing to a 7.76 g/cm^3 density with less than 1% porosity. Specimens of both powder steels and standard steel were face quenched from 800°C in water, for a determination of their hardenability and cooling kinetics. Prior to mechanical tests, specimens were quenched from 850°C in oil (powder-alloy steel, standard steel) or in water (powder-mixture steel) and then tempered at 580°C. Examination under an electron microscope revealed a homogeneous microstructure of

powder-alloy steel and standard steel. The microstructure of powder-mixture steel was found to contain nonetchable lumps consisting or irregularly precipitated Fe_3C laminae. The results of mechanical tests in an "MTS" universal tensile machine for ultimate and 0.2% yield strength, percentage elongation and reduction, and toughness indicate that, while the characteristics of powder-alloy steel approach those of standard steel, those of powder-mixture steel are far below. References 4: all Russian.

2415/12947
CSO: 1842/238

UDC 669.25'859:620.18

MAGNETIC STRUCTURE OF Co-R.E.M. POWDER-ALLOY MAGNET

Kiev POROSHKOVAYA METALLURGIYA in Russian No 6, Jun 86 (manuscript recieved 6 Dec 84) pp 72-76

[Article by G. I. Yaglo, A. I. Polishchuk, Yu. V. Gusev, V. F. Stolyar, Ye. P. Serdyukov and S. I. Yegorova, Scientific Research Institute of Permanent Magnets and Institute of Agricultural Machine Building]

[Abstract] The magnetic structure and properties of a permanent magnet produced from 63% Co+ 37% Sm powder are analyzed on the basis of experimental data and their interpretation according to the theory of magnetism. Specimens of such a magnet were produced by fusion in a vacuum induction furnace with an atmosphere of pure Ar. Wet powder, obtained by grinding with ethanol after dry grinding in a ball mill, was molded under a pressure of 1 GPa in a magnetic field of approximately 15 kOe intensity and then sintered in a vacuum furnace under a residual pressure of 1.33 mPa. Specimens for testing were cut by the electric-spark method. Measurements of the magnetic moment and its rotation under static loading till fracture revealed an incomplete axial grain orientation, regardless of the magnetization level up to saturation, with regions of nonparallel orientation of the magnetic moment relative to the resultant magnetic moment. These regions were found to lower the residual magnetization, its level decreasing with an increasing disorientation angle. References 4: all Russian.

2415/12947
CSO: 1842/238

UDC 621.791.755

HARDWARE AND SOFTWARE FOR PLASMA WELDING AND FACING IN FLEXIBLE PRODUCTION SYSTEMS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 7, Jul 86 pp 1-2

[Article by N. A. Sosnin, candidate of technical sciences, S. A. Yermakov, engineer, and B. L. Vichik, engineer]

[Abstract] Use of the UPS-301 manual plasma welding apparatus, now series produced at the Elektrik plant in Leningrad, is considered as a basis for robotized welding and facing operations in a flexible production system. This requires only appropriate hardware and software for process mechanization and automation, the technological advantages of a plasma arc being most effectively realized with the plasmatron moving relative to the stationary work piece. The control algorithm should most expediently be based on maximization of thermal efficiency, which according to N. N. Rykhalin depends on the heat source configuration and the radiative heat transfer coefficients. Calculations have been made for welding and facing VT1-0 titanium-tungsten alloy and AMgo aluminum-magnesium alloy in various configurations with a PS-3 plasmatron. The algorithm has been programmed in FORTRAN so as to be universally applicable to other metals and alloys or steels as well. References 2: both Russian.

2415/12947
CSO: 1842/245

UDC 621.791.03-52

ADAPTIVE CONTROL OF ARC-WELDING ROBOT WITH AID OF INDUCTIVE TRANSDUCERS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 7, Jul 86 pp 3-5

[Article by A. I. Bondarenko, candidate of technical sciences, L. G. Chatskis, engineer, and V. N. Skorina, engineer, Electric Welding Institute imeni Ye. O. Paton]

[Abstract] A special inductive transducer for adaptive control of an arc-welding robot has been developed at the Electric Welding Institute. It

records changes in electric and magnetic field intensities as a measure of its distance from the surface of the welded object. The transducer contains magnetizing and measuring coils with a capacitor connected across the measuring coil so as to form a resonance circuit and thus improve the sensitivity. The design is based on a.c. circuit theory and derived from the model of a conductor array in a dielectric medium above an ideally conducting half-space. Two such distance transducers in an orthogonal configuration are key elements of an adaptive control system which in addition includes an Elektronika-60 microcomputer, an input-output device, a setting device, two registers, a position feedback, a velocity feedback, a velocity feedback, a digital-to-analog converter, a thyristor inverter, a program switch, a commutator, a servomotor, and a servomechanism for the welding tool manipulator. The system has been designed and tested for guidance of the welding torch onto the welding seam line, its positioning accuracy being without 0.7 mm. References 8: 6 Russian, 2 Western (1 in Russian translation).

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STANDARD ROBOTIZED RESISTANCE-WELDING STATIONS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 7, Jul 86 p 5

[Article by B. P. Golovlev, engineer, V.A. Ryazanov, engineer, and A. D. Selyunin, engineer]

[Abstract] A robotized station for resistance welding of parts up to 500x500 mm² has been laid out, its principal equipment consisting of "Universal 60.02" industrial robots with UPM-772 numeric program control, self-aligning vise or MTP-803 welding machine with PTsS welding cycle regulator, and a VDM-400U vertical turntable. Other equipment includes a work bench, a bin for finished welding assemblies, a G48-42 pump set, and a drive with controls. The layout has been standardized and can be modified for resistance welding of larger parts, typically 1500x700 mm² side panels of Izhev Plant IZh 21251 automobiles. In this case four "Universal 60.02" industrial robots are needed and a horizontal turntable is preferred. Spot welding at 360 points at a rate of 60 points/min in such a station should save 32,000 rubles annually in production costs. References 2: all Russian.

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FLUX FOR SOLDERING TOGETHER DIFFERENT METALS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 7, Jul 86 pp 25-26

[Article by V.G. Polnov, engineer, M. N. Mogilner, candidate of technical sciences, R. I. Shenk, engineer, and G. N. Ivanova, engineer, All-Union Scientific Research Institute of Pipe Fittings (VNIITarmatura), Alma-Ata]

[Abstract] A technology with use of a new flux has been developed for soldering parts of easily cast gray iron to parts of mechanically stronger and corrosion resistant steel. This flux, on a borax base with Ca-Si modifier, was tested with L63 Cu-Zn solder. The modifier was found to ensure wetting of cast iron and spreading over its surface. A solid joint is produced by heating to the solder temperature and subsequent air cooling. The glassy flux film is then removed by lateral tapping of the joint with a mallet. The flux composition has been optimized for use with commercial P-100 solder (50-66.5% Cu + 19-23% Zn + 6-10% Mn + 5-9% Fe + 2-6% Ni + 1.5-2.0% Cr) or P-102 solder (72.5-80.5% Cu + 8-10% Zn + 8-10% Sn + 2-4% Fe + 1-2% Ni + 0.5-1.5% Cr) in pellet form, for soldering cast iron to low-alloy or stainless steels. References 4: all Russian.

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EXTRACTIVE METALLURGY AND MINING

PROGRESS IN METALLURGY SUMMARIZED

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 20 Jul 86 p 1

[Article: "Today is Metallurgy Day"]

[Text] Metallurgy is welcoming its professional holiday with considerable successes. It has produced hundreds of millions of rubles of iron, steel, rolled stock, nonferrous metals, and alloys above the program.

Among the leaders in the competition are the renowned collectives of the Magnitogorsk, Novolipetsk, and West Siberian Metallurgical Combines, the Norilsk and Amalyk Mining and Smelting Combines, the Zaporozhye, Bereznii and Ust-Kamenogorsk Titanium-Magnesium Combines, the Glinozem, Nikel, Tulachermet, and Yakutalmaz Associations, and other enterprises.

The industry is undergoing intense technical re-equipment, renovating production facilities, introducing high-efficiency technologies, and sharing advanced experience. This will make it possible to increase labor productivity, reduce cost of production, assimilate hundreds of economical types of articles, and reduce consumption of raw materials and energy resources.

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METHODS OF RECOVERING SULFUR FROM FLUE GASES AT NORILSK MINING AND METALLURGICAL COMBINE

Moscow TSVETNYYE METALLY in Russian No 7, Jul 86 pp 49-52

[Article by V. S. Filippov and R. F. Karaseva]

[Abstract] Metallurgical plants of the Norilsk Mining and Metallurgical Combine process sulfide ores of copper and nickel. Until 1969 principally sulfuric acid for internal needs was produced from flue gases. Since the Nadezhdinskiy Metallurgical Plant has been put in operation, commercial sulfur is also being produced during hydrometallurgical processing of pyrrhotite concentrate and from flue gases of suspension smelting furnaces. Because of the geographical location and available transportation facilities, there is a much better market for commercial sulfur than for sulfuric acid from the Norilsk Combine. So far the breakdown of sulfur available for production is 30% in sulfur-deficient (0.15-1.8% SO_2) gases from agglomerating equipment, nickel smelting electric furnaces, and copper smelting reverberatory furnaces, 32% in sulfur-lean (2-3.5% SO_2) converter gas, 8% in gas (5% SO_2) from KS Kilns for copper and nickel, and thus only 30% in sulfur-rich (12-20% SO_2) gases from suspension smelting furnaces and liquid baths. Significant improvement of this balance requires redesign and reorganization of the copper and nickel production plants, namely replacement of electric and reverberatory smelting with autogenic smelting in liquid baths, while leaving intact the already proficient production of sulfuric acid. A comparative technical and economic analysis of production and transportation methods indicates the feasibility of recovering up to 47% of all sulfur from rich gases or, upon conversion, up to 83% from all lean and rich gases, with a strong preference for production of sulfur in granular rather than lump or liquid form. References 3: all Russian.

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UDC 669.295

STRUCTURE OF REVERSIBLE CONDENSATE IN TITANIUM PRODUCTION BY PROCESSING WITH MAGNESIUM UNDER HEAT

Moscow TSVETNYYE METALLY in Russian No 7, Jul 86 pp 67-69

[Article by V. I. Oleynichenko, V. M. Malshin and L. K. Mineyeva]

[Abstract] Residual magnesium and $MgCl_2$ is purged from titanium sponge by heating under vacuum, then condensed in a way to minimize the moisture content and to make the magnesium reusable for reduction of titanium ore. Compactness of the condensate depends on the temperature characteristics of the condenser as well as on the scavenger pressure and temperature. A study of the condensate structure in a vertical condenser was made for a determination of this dependence. A fusible plug was used as scavenger. The process was terminated after 3 h of purging, only the initial stages being relevant to structurization of the condensate. The condensate was sprinkled for cooling immediately after the heating furnace had been turned on in some tests and 1 h after the plug had melted in other tests. The pressure, above the dew point, was recorded continuously during a test run. After the furnace had been turned off, argon was injected into the condenser so as to terminate both purging and condensation. The condenser was then cooled to room temperature. Specimens of the condensate were weighed and their thickness was measured. Chemical analysis revealed an average composition of 93.8% Mg and 6.2% $MgCl_2$. Macrostructural and microstructural examination revealed a compact columnar-fibrous deposit of almost uniform thickness covering the lower part of the condenser wall and strongly bonded to it, more than 2/3 of the wall height after tests without cooling and less than 1/2 of the wall height after tests with immediate sprinkling. The upper part of the condenser wall was found to have been covered with a friable granular deposit containing conical crystallite concretion of various sizes loosely bonded to one another and to the condenser wall. Such a nonhomogeneity of the Mg condensate is attributable to nonuniformity of the temperature field in the condenser. As the results indicate, delayed sprinkling of the condenser may improve the quality of the condensate. References 6: all Russian.

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REFINING CAST SECONDARY ALUMINUM ALLOYS BY REMOVAL OF MAGNESIUM WITH TAILINGS OF TITANIUM-MAGNESIUM PRODUCTION

Moscow TSVETNYYE METALLY in Russian No 7, Jul 86 pp 84-85

[Article by I. Ye. Todoraki and A. A. Ofengenden]

[Abstract] Use of tailings from titanium-magnesium production instead of cryolite for removal of magnesium from cast secondary aluminum alloys is under

study at the All-Union Scientific Research Institute of Secondary Nonferrous Metals (VNIIPvtortsvetmet). The principle is the same, namely that chlorides of other metals in the tailings decompose in the molten scrap and $MgCl_2$ as well as $AlCl_3$ form instead because of their higher free energy. In the melt $AlCl_3$ reacts with remaining metallic Mg so that more nonvolatile $MgCl_2$ forms, whereupon this chloride rises to the surface. Evaporation of $AlCl_3$ from the surface is prevented by its absorption in the salt melt containing KCl and NaCl as well as $MgCl_2$, followed by formation of chloroaluminate complexes. The process was experimentally tried on AK5M7 alloy, containing 0.5% Mg, with extra Mg up to 2% added. Three equal batches for treatment with different refining agents were melted simultaneously in separate graphite crucibles. Approximately the same amounts of chloride melt from reprocessed pulp, spent chlorator melt, and vat deposits from vanadium production were consumed, 3.80-4.06 kg, for removing 1 kg Mg within a period of 15-18 min. While treatment with spent chlorator increased the Fe content, treatment with either chloride melt or vat deposits did not have this or any other detrimental effect. References 4: 3 Russian, 1 Western.

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WELDING OF ALUMINUM ALLOYS WITH MOLTEN FILLER METAL AND WITH MILLING OF EDGES

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 7, Jul 86 pp 14-15

[Article by V. I. Stolbov, doctor of technical sciences, Yu. V. Kazakov, candidate of technical sciences, and Z. A. Shamugiya, engineer, Tolyatti Polytechnic Institute]

[Abstract] A method of fusion welding aluminum alloys is described which will produce a joint with a seam not too much weaker than the base metal, the requirement for this being to concentrate only the minimum heat necessary within the welding zone. This is achieved by using molten filler metal and milling the edges of the two parts in contact. A circular milling cutter is immersed in the pool of molten filler metal and, while rotating, cuts a slot between the two contiguous parts. Molten filler metal flows into this slot and flashes it forming, upon solidification, the seam. A study of this technology was made, including microstructural examination of the seam and of the thermal influence zone under an MIM-7 optical microscope as well as microhardness measurement with a PMT-3 tester using a 10 g load. The method was evaluated on 12 mm thick plates of quenched and artificially aged 1201 aluminum alloy, such a heat treatment making this alloy particularly sensitive to heating and prone to softening. Slots were cut with a 3 mm wide milling tool rotating at a speed of 420 rpm, at a feed rate of 65 mm/min equivalent to a welding rate of 4 m/h, in a pool of molten 1201 aluminum alloy also used as filler at a temperature of 670-700°C. Seams as long as 200 mm and 5-6 mm wide at the face tapering to 4 mm at the root were thus produced, with a thermal influence zone not wider than 25-28 mm and consisting of copper-in-aluminum solid-solution grains and $CuAl_2$ intermetallic compound along the grain boundaries. Mechanical tests yielded a tensile strength of 260-270 MPa and thus only 36-38% lower than that of the base metal, fracture occurring first within the main seam zone. References 4: all Russian.

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SOLDERING NIPPLE JOINTS BETWEEN SMALL-DIAMETER STEEL PIPES

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 7, Jul 86 pp 15-16

[Article by I. A. Frolov, candidate of technical sciences, and K. I. Frolov, engineer, Voronezh Construction Engineering Institute]

[Abstract] The development of a new technology for soldering nipple joints between pipes of 10Cr18Ni9Ti steel 4-6 mm in diameter with 1 mm wall thickness required a finishing touch, namely evaluation of a powder-alloy solder (10-200 μm grain size fraction) consisting of 23.8-51.95% Ni + 38-55% Mn + 4-8% Cr + 2-6% W + 2-4% Fe + 2-4% Si + 0.05-0.2% B. This solder contains the optimum amount of the eutectic Ni-Mn-Si component, which prevents formation of voids in the unfilleted zone. Evaporation of Mn and other elements such as boron must be prevented by optimizing the heater position relative to the lap joint so that most heat is applied to the heaviest pipe joint segment. Nipple joints were experimentally produced for establishing the proper lap length, within 80-120% of the pipe diameter. These joints withstood hydrostatic tests under a pressure of 39.2 MPa and passed helium leak tests. References 5: all Russian.

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